FINAL FEASIBILITY STUDY REPORT OPERABLE UNIT 7 (OU7) NSY PORTSMOUTH ME
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TETRA TECH

Final
Feasibility Study Report for
Operable Unit 7

Portsmouth Naval Shipyard

Kittery, Maine

Naval Facilities Engineering Command
Mid-Atlantic
Contract Number N62470-08-D-1001
Contract Task Order WE13

June 2013

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FINAL
FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 7

FOR

PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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REVISION LIST

Section	Revision	Description
Cover	Revision 0; June 2013	The cover page was updated to reflect the final document dated June 2013.
Final Feasibility Study for Operable Unit 7 Signature Page	Revision 0; June 2013	The signature was signed and updated to indicate the document is final as of June 2013.
Maine PE Certification Page	Revision 0; June 2013	The Maine PE signature and seal was provided.
Table of Contents	Revision 0; June 2013	The table of contents (pages v to vii) was updated to include a revisions list (page iii). The Maine PE Certification Page is now page iv. Pages viii to x (Acronyms and Abbreviations) were also dated June 2013.
Appendix A	---	Appendix A.1 was updated based on the responses to MEDEP comments on the draft final document. Entire Appendix A was reprinted.
Appendix F – Responses to Comments	---	The responses to MEDEP comments on the draft final document was included at the end of Appendix F.

I hereby acknowledge that this document, Feasibility Study for Operable Unit 7, Portsmouth Naval Shipyard, Kittery, Maine, was prepared with my consultation and review.

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June 2013
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ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
4,4-DDE	Dichlorodiphenyldichloroethylene
4,4-DDT	Dichlorodiphenyltrichloroethane
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
BAP	Benzo(a)pyrene
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMR	Code of Maine Rules
COC	Chemical of concern
COPC	Chemical of potential concern
CSF	Cancer Slope Factor
CTE	Central tendency exposure
CTO	Contract Task Order
CWA	Clean Water Act
DoD	Department of Defense
EPC	Exposure point concentration
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement
FS	Feasibility Study
FY	Fiscal year
GHG	Greenhouse gas
GRA	General response action
HHRA	Human health risk assessment
HI	Hazard index
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
ILCR	Incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LTMgt	Long-term management
LUC	Land use control

MEDEP	Maine Department of Environmental Protection
mg/kg	Milligram per kilogram
MLW	Mean low water
MRSA	Maine Revised Statutes Annotated
MTADS	Multi-Sensor Towed-Array Detection System
NAD	North American Datum
NAVD88	North American Vertical Datum of 1988
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPW	Net Present Worth
NRWQC	National Recommended Water Quality Criteria
O&M	Operation and maintenance
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PNS	Portsmouth Naval Shipyard
PPE	Personal protective equipment
ppt	Part per thousand
PRAP	Proposed Remedial Action Plan
PRG	Preliminary remediation goal
RAB	Restoration Advisory Board
RAGs	Remedial Action Guidelines
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfD	Reference Dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendment and Reauthorization Act

SMP	Site Management Plan
SSI	Site Screening Investigation
SVOC	Semi-volatile organic compound
SWMU	Solid Waste Management Unit
TBC	To be considered
TEQ	Toxicity equivalency quotient
TSCA	Toxic Substance Control Act
TSD	Treatment, storage, and disposal
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile organic compound
µg/kg	Microgram per kilogram

EXECUTIVE SUMMARY

INTRODUCTION

This Feasibility Study (FS) Report for Operable Unit (OU) 7 at Portsmouth Naval Shipyard (PNS), Kittery, Maine, was prepared by Tetra Tech for the United States Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under the Comprehensive Long-Term Environmental Action Navy (CLEAN) program, Contract Number N62470-08-D-1001, Contract Task Order (CTO) WE13. This report describes the formulation and evaluation of remedial alternatives to address the potentially unacceptable risks at OU7 to human health and the environment based on the results of the Remedial Investigation (RI) Report for OU7 (Tetra Tech, 2011). This FS was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). As required by CERCLA, primary consideration is given to remedial alternatives that provide adequate protection of human health and the environment and alternatives that attain or exceed the regulatory requirements and guidance that may potentially govern remedial activities. In addition to CERCLA requirements, this FS was also prepared with consideration of other regulatory requirements and guidance, as appropriate.

OU7 consists of Site 32 – Topeka Pier Site. Evaluations of remedial alternatives to address potentially unacceptable risks to human health and the environment for OU7 are presented in this FS. The FS was conducted to establish Remedial Action Objectives (RAOs), to screen remedial technologies, and to assemble, evaluate, and compare remedial alternatives that will be used in selecting a remedial action for OU7. A Proposed Remedial Action Plan (PRAP) will be submitted after the FS is finalized and will present the Navy’s recommended remedial action for OU7 based on the information provided in this FS.

CONCEPTUAL SITE MODEL

The majority of OU7 is covered by pavement or buildings with some small areas of grass landscaping. A boat ramp near the former Topeka Pier provides access to the intertidal area. Access to the intertidal area from other portions of OU7 is more difficult because of the steeper slope and large rocks and boulders on the upper portion of the shoreline. Current onshore land use for OU7 is industrial with recreational use in the intertidal area (boat pier). The site uses are likely to remain as they are currently. However, unrestricted residential, recreational, or industrial use of the site may be possible future scenarios if the Shipyard were to close. Sufficient habitat at OU7 is not available for onshore ecological receptors at OU7; therefore, ecological exposure is not considered significant. Primary sources of contamination at OU7 are from past filling activities (from approximately 1900 to 1945) conducted to extend the shoreline and industrial use of the site (including a former timber basin). The fill material is mostly rock and soil, intermingled with some debris. There are a few intermittent pockets of debris with little soil. Evaluation of potential risks for people who may be exposed to chemicals in surface or subsurface material at OU7 or in surface water or sediment in the intertidal area indicated that the only potentially unacceptable risks are for hypothetical future residential exposure to surface or subsurface soil and industrial user (construction or occupational worker) exposure to subsurface soil. Potential contaminant migration from fill material through groundwater transport, including through sediment, seeps, and the storm sewer system is not a current unacceptable risk and would not be a future unacceptable risk. Potential contaminant migration from fill material to the offshore area, if shoreline controls were to fail, is considered a future potential unacceptable risk.

MEDIA OF CONCERN

The media of concern that pose potentially unacceptable risk are surface and subsurface soil. Soil is a medium of concern because there are potentially unacceptable risks for a hypothetical future residential receptor exposed to surface soil from 0 to 2 feet below ground surface (bgs) and for hypothetical future residential receptors and industrial users exposed to subsurface soil from 2 to 10 feet bgs (Tetra Tech, 2011). Soil is also a medium of concern if soil along the shoreline erodes to the offshore area in the future. Based on the risk assessment conclusions presented in the RI Report (Tetra Tech, 2011), groundwater and intertidal sediment and surface water are not media of concern for OU7. Chemicals of concern (COCs) for soil include antimony, copper, iron, lead, carcinogenic polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins/furans.

REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. RAOs are required to specify the COCs, exposure routes and receptors of concern, and an acceptable contaminant level or range of levels for each exposure route. Acceptable contaminant levels are based on site-specific preliminary remediation goals (PRGs) as a starting point, after which a final remediation goal is determined when a remedy is selected. For remedial evaluations, the carcinogenic PAHs are evaluated in terms of equivalency of toxicity to benzo(a)pyrene (BAP) expressed as a single concentration called the BAP toxicity equivalency quotient (TEQ), dioxins/furans are evaluated in terms of equivalency to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQ, and PCBs are based on total PCBs. The following RAOs have been developed for OU7:

- Prevent residential exposure through ingestion of, dust inhalation of, and dermal contact with surface soil containing lead and subsurface soil containing antimony, copper, iron, lead, carcinogenic PAHs, PCBs, and dioxins/furans concentrations exceeding residential PRGs.

- Prevent industrial worker (construction and occupational) exposure through ingestion of, dust inhalation of, and dermal contact with subsurface soil containing dioxins/furans and PCB concentrations exceeding industrial PRGs.

- Protect the offshore environment from erosion of contaminated soil from the OU7 shoreline.

PRGs are chemical-specific goals for representative site concentrations (based on a representative exposure concentration for an exposure unit, not individual sample result concentrations) that, when achieved, will result in site concentrations that pose an acceptable risk for the targeted receptor. PRGs have been developed on a receptor-specific basis for protection of human health from exposure to soil contaminants. The PRGs were used to determine the remediation areas and volumes to be addressed by alternatives in this FS. Remediation areas for surface soil for hypothetical future residential exposure and for subsurface soil for industrial exposure were based on the elevated concentrations of lead in surface soil and dioxins/furans and PCBs in subsurface soil found within a portion of the former timber basin. For hypothetical future residential exposure to subsurface soil, the majority of the site was identified as the remediation area. The entire area of shoreline controls was identified as the remediation area for potential future erosion.

DEVELOPMENT OF ALTERNATIVES

The primary objective of this phase of the FS was to develop an appropriate range of remedial alternatives from applicable technology types and process options. The No Action alternative is included, as required under CERCLA, to establish a basis for comparison with other alternatives. Two alternatives were developed for OU7 in addition to No Action (Alternative 1); Land Use Controls (LUCs) and Long-Term Management (LTMgt) of Shoreline Controls (Alternative 2), and Limited Excavation in Former Timber Basin Area, Residential LUCs, and LTMgt of Shoreline Controls (Alternative 3). An alternative for excavation of contaminated material across the entire site to achieve unlimited use and unrestricted exposure was not fully developed because of high costs (excavation and disposal alone would be approximately $17 million) and the disruption that construction would cause to day-to-day Shipyard operations (e.g. potential utility interferences and parking restrictions).

DETAILED AND COMPARATIVE ANALYSIS OF ALTERNATIVES

In the detailed analysis section of this FS, each alternative is evaluated against seven of the nine CERCLA criteria. In selecting a remedy, in accordance with CERCLA, overall protectiveness of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs) are "threshold criteria" that *must* be satisfied for an alternative to be eligible for selection. Reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, long-term effectiveness and permanence, implementability, and cost are "balancing criteria" that are used to weigh trade-offs among alternatives. Two of the nine CERCLA criteria (state and community acceptance), not evaluated as part of this FS, are "modifying criteria." After a preferred alternative has been identified and submitted for public comment via the PRAP, the modifying criteria are taken into account during preparation of the Record of Decision (ROD). Table ES-1 provides a summary of the comparative analysis.

TABLE ES-1: SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

ALTERNATIVE	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Estimated Time Frame (months)			
Designing and Constructing the Alternative	N/A	12	12
Achieving the Cleanup Objectives	N/A	12	14
Criteria Analysis			
Threshold Criteria			
Protects Human Health and the Environment ➢ Will it protect you and plant and animal life on and near the site?	○	●	●
Meets federal and state regulations ➢ Does the alternative meet federal and state environmental statutes, regulations and requirements?	N/A	●	●
Primary Balancing Criteria			
Provides long-term effectiveness and is permanent ➢ Will the effects of the cleanup last?	○	◉	●
Reduces mobility, toxicity, and volume of contaminants through treatment ➢ Are the harmful effects of the contaminants, their ability to spread, and the amount of contaminated material present reduced?	○	○	○
Provides short-term protection ➢ How soon will the site risks be reduced? ➢ Are there hazards to workers, residents, or the environment that could occur during cleanup?	N/A	●	●
Can it be implemented ➢ Is the alternative technically feasible? ➢ Are the goods and services necessary to implement the alternative readily available?	N/A	●	◉
Cost ($) ➢ Upfront costs to design and construct the alternative (capital costs) ➢ Operating and maintaining any system associated with the alternative (O&M costs) ➢ Periodic costs associated with the alternative (periodic costs) ➢ Total cost in today's dollars (30-year NPW cost)	$0	$15,000 capital 30-year NPW: $381,000	$760,000 capital 30-year NPW: $1,127,000
Modifying Criteria			
State Agency Acceptance ➢ Does MEDEP agree with the Navy's recommendation?	To be determined after the public comment period on the Proposed Remedial Action Plan.		
Community Acceptance ➢ What objections, suggestions, or modifications does the public offer during the comment period?	To be determined after the public comment period on the Proposed Remedial Action Plan.		
Relative comparison of the nine balancing criteria and each alternative: ● – Good , ◉ – Average, ○ – Poor; N/A – not applicable			

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This Feasibility Study (FS) Report for Operable Unit (OU) 7 at Portsmouth Naval Shipyard (PNS), Kittery, Maine, was prepared by Tetra Tech for the United States Department of the Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under the Comprehensive Long-Term Environmental Action Navy (CLEAN) program, Contract Number N62470-08-D-1001, Contract Task Order (CTO) WE13. This report describes the formulation and evaluation of remedial alternatives to address the potentially unacceptable risks at OU7 to human health and the environment based on the results of the Remedial Investigation (RI) Report for OU7 (Tetra Tech, 2011). This FS was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). As required by CERCLA, primary consideration is given to remedial alternatives that provide adequate protection of human health and the environment and alternatives that attain or exceed the regulatory requirements and guidance that may potentially govern remedial activities. In addition to CERCLA requirements, this FS was also prepared with consideration of other regulatory requirements and guidance, as appropriate.

1.2 SCOPE AND OBJECTIVES

Evaluations of remedial alternatives to address potentially unacceptable risks to human health and the environment for OU7 are presented in this FS. Remedial alternatives include options to protect the offshore area from potential impacts associated with OU7 contamination (i.e., erosion of contaminated soil to the offshore area); however, contamination in the offshore area adjacent to OU7 will not be addressed as part of OU7. This offshore area is included in OU4.

The FS was conducted to establish Remedial Action Objectives (RAOs), to screen remedial technologies, and to assemble, evaluate, and compare remedial alternatives to be used in selecting a remedial action for OU7. A Proposed Remedial Action Plan (PRAP) will be submitted after the FS is finalized and will present the Navy’s recommended remedial action for OU7, based on the information provided in the FS. This FS fulfills the requirements of CERCLA and is consistent with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988) and the Navy Environmental Restoration Program (NERP) Manual, Chapter 8 (Navy, 2006).

1.3 REPORT ORGANIZATION

This report has been divided into the following five sections:

- Section 1.0 – Introduction: This section provides a description of the purpose, scope, and objectives of the FS. This section also provides a summary of background information and the OU7 RI Report.

- Section 2.0 – Remedial Action Objectives: This section presents Applicable or Relevant and Appropriate Requirements (ARARs), the media of concern, RAOs, preliminary remediation goals (PRGs), and areas and volumes of soil to be addressed by the remedial alternatives for OU7.

- Section 3.0 – Identification and Screening of Technologies and Development of Alternatives: This section discusses the general response actions (GRAs) identified to attain the RAOs, the screening of technology types and process options, description and evaluation of technologies, and development of alternatives.

- Section 4.0 – Description and Detailed Analysis of Remedial Alternatives: This section describes the conceptual design of the alternatives and discusses the detailed analysis of alternatives using the seven criteria of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

- Section 5.0 – Comparative Analysis of Alternatives: This section provides a comparison of the alternatives using the detailed analysis information in Section 4.0.

Appendix A provides supporting information including a discussion of PRG development, and additional risk evaluations to estimate post-remedial risks. Appendix B provides alternative-specific ARARs tables. Appendix C provides the cost estimates for the alternatives. Appendix D includes area and quantity calculations. Appendix E provides an environmental footprint evaluation of remedial alternatives in this FS. Appendix F provides responses to comments on this FS Report.

1.4 FACILITY AND OU7 BACKGROUND INFORMATION

A description of PNS and the history of the facility, as well as a description and history of OU7, are provided in this section.

1.4.1 Facility Description and History

PNS is a military facility with restricted access on an island located in the Piscataqua River, as shown on Figure 1-1. The Piscataqua River is a tidal estuary that forms the southern boundary between Maine and New Hampshire. PNS is located in Kittery, Maine, north of Portsmouth, New Hampshire, at the mouth of the Great Bay Estuary (commonly referred to as Portsmouth Harbor).

PNS is engaged in the conversion, overhaul, and repair of submarines for the Navy. The long history of shipbuilding in Portsmouth Harbor dates back to 1690, when the first warship launched in North America, the Falkland, was built. PNS was established as a government facility in 1800, and it served as a repair and building facility for ships during the Civil War. The first government-built submarine was designed and constructed at PNS during World War I. A large number of submarines have been designed, constructed, and repaired at this facility since 1917. PNS continues to service submarines as its primary military focus.

Prior to CERCLA and Resource Conservation and Recovery Act (RCRA) regulations, years of shipbuilding and submarine repair work at PNS resulted in hazardous substances being released into soil, groundwater, surface water, and sediment on and around Seavey Island. As a result, investigation and remediation activities were performed under the Department of Defense (DoD) Installation Restoration Plan (IRP). Paralleling CERCLA, the IRP focuses on the cleanup of contamination from past hazardous waste operations and past hazardous material spills. The IRP is further discussed in the Site Management Plan (SMP) for PNS [Amended Fiscal Year (FY) 12] (Navy, 2012).

Investigations of hazardous substance releases at PNS began in 1983 with the Initial Assessment Study (IAS) (Weston, 1983). USEPA became involved with PNS in 1985 when the agency requested information on PNS hazardous wastes and conducted a visual site inspection under the authority of RCRA. Since 1988, Maine Department of Environmental Protection (MEDEP) has also provided oversight of investigation and remediation at PNS. In March 1989, USEPA issued a Corrective Action Permit under the RCRA Hazardous and Solid Waste Amendments (HSWA) of 1984 (USEPA, 1989) that required PNS to investigate 13 Solid Waste Management Units (SWMUs) and take appropriate corrective action. Until the mid-1990s, investigations at PNS were conducted under RCRA authority. Effective May 31, 1994, PNS was included on the National Priorities List (NPL), and subsequent studies have been conducted under the authority of CERCLA, commonly known as Superfund. Consistent with the transition from RCRA to CERCLA, the SWMU terminology was replaced with “site.” Ongoing work meets the intent of the HSWA Permit, but the ongoing studies to develop and evaluate remedial activities are conducted as part of FSs (CERCLA terminology) which combine both RCRA and CERCLA criteria.

The Federal Facility Agreement (FFA) for PNS was signed by USEPA and the Navy in September 1999, became effective February 2000, and supersedes the HSWA Permit. The State of Maine has elected not to be a party to the FFA at this time. However, the state is afforded a participatory role in the site remediation process by virtue of CERCLA. Among other things, the FFA outlines roles and responsibilities, establishes deadlines/schedules, outlines work to be performed, and provides a dispute resolution process for primary documents. The FFA for PNS ensures that CERCLA decisions will be consistent with RCRA and other federal and state hazardous waste statutes and regulations as appropriate for the sites at PNS. USEPA, MEDEP, and the Navy continue to work toward site cleanup at PNS under CERCLA.

1.4.2 OU7 Description

OU7 is located along the northern boundary of PNS and consists of Site 32 – Topeka Pier Site. The general layout of OU7, which encompasses approximately 19 acres (including the shoreline area), is shown on Figure 1-2; the OU7 site boundary which is an irregular shape is defined by the historical fill in this area. Interim offshore monitoring stations MS-03 and MS-04, which are included in OU4 but could potentially be impacted by OU7 in the future if shoreline controls would fail, are located offshore of OU7 as shown on Figure 1-2.

Currently land use at OU7 includes office parking, equipment storage, vehicle and rail car maintenance, transducer repair, boat launching, and a hotel (Building H23 in the southeastern corner of the site). A boat ramp near Topeka Pier provides access to the intertidal area.

1.4.3 OU7 History

Before 1900, a waterway (Jenkin's Gut) extended southwest to northeast between Dennett's and Seavey Islands. From 1900 to 1910, during construction of Dry Dock No. 2, material excavated from the southern end of the channel was deposited in the northern end of the channel, connecting Dennett's and Seavey Islands. During the same time period, Topeka Pier was constructed in the Back Channel of the Piscataqua River to dock the prison ship USS Topeka. OU7 was created from various filling activities. Storing and milling of lumber in the area began by 1910, and a timber basin was established in the south central portion of the site. An approximate location of the timber basin based on historical figures is shown on Figure 1-2. The filled area west of the timber basin was used to store coal, wood, and scrap iron.

Filling of the shorelines at OU7 continued through the 1930s. Fill material included rock, earth, cinders, and other debris and scrap material that could not be destroyed by incineration. Various cans and drums were reportedly disposed of in the area, possibly containing sodium hydroxide, sulfuric acid, and organic solvents, but investigations of OU7 have not shown any indication of the presence of such cans or drums. By 1939, combustible material was being dumped in the southern portion of the site (within the timber basin), in the area of current Building 158, for disposal. By 1945, filling of the area had ceased. Additional information on the historical filling and uses of OU7 and historical maps are provided in the OU7 RI Report (Tetra Tech, 2011).

Many buildings were constructed on the land created by filling activities, including a transportation and equipment storage building (Building 154), net storage building that was converted to a garage (Building 158), electrical sub-station (Building 162), torpedo overhaul and storage building (Building 176), several storehouses (Buildings 112, 177, and 197), a hotel (Building H23), and an office building (Building H29). Buildings 112, 197, and H29 were later demolished. Building 154 is used primarily for garage space and diesel locomotive engine repair, and Building 306 is used as a transducer repair facility. Portions of the parking area east of Building 154 were repaved in 2003 and 2004, and Building 237 (former Public Works Administrative Building) was demolished in 2007. A new transducer testing facility east of Building 306 was constructed in 2009. As part of construction of a new building west of OU7, a new parking area was constructed in the location of former Building 237. Additionally, Topeka Pier was removed in 2011 and replaced in 2012.

Excavation work performed by Shipyard personnel along Goodrich Avenue in 1994 and 1995, near Building H23, uncovered debris including large dry-cell batteries, graphite electrodes, brick, wood, metal pipe and wire, glass, and asbestos cloth. Crucibles were also identified during excavation activities, indicating the presence of foundry waste. Subsequently, the area was defined as a potential IRP site and environmental investigations began as discussed further in Section 1.5.

1.5 SUMMARY OF OU7 ENVIRONMENTAL INVESTIGATIONS AND ACTIONS

The data from previous investigations were used to evaluate site characteristics, the nature and extent of contamination, and site risks. A summary of the OU7 RI Report, including nature and extent of contamination, is presented in Section 1.6. Table 1-1 provides brief summaries of the previous investigations at OU7.

TABLE 1-1 PREVIOUS INVESTIGATIONS AND SITE DOCUMENTATION

INVESTIGATION	DATE	ACTIVITIES
RCRA Facility Investigation (RFI) Data Gap Investigation (Halliburton NUS, 1995)	1994	The RFI Data Gap Investigation provided geological and hydrogeological information for one location at OU7, the FA monitoring well cluster. Data from the RFI Data Gap Investigation were considered along with other geological and hydrogeologicial information to evaluate OU7 conditions, including contaminant fate and transport. Groundwater chemical data from the RFI Data Gap Investigation are not included in the OU7 data set because the data are not considered representative of site conditions.
Groundwater Monitoring (Tetra Tech, 1999)	1996-1997	Four rounds of groundwater data were collected between December 1996 and November 1997 in response to the RFI to support future FS reports. The data from the 1996 to 1997 groundwater monitoring were used as part of data evaluation activities for the RI.

TABLE 1-1 PREVIOUS INVESTIGATIONS AND SITE DOCUMENTATION

INVESTIGATION	DATE	ACTIVITIES
Seep and Sediment Monitoring (Tetra Tech, 2000b)	1996-1997	Seep water and collocated sediment samples were collected in several intertidal areas of PNS (i.e., areas exposed during low tide and submerged during high tide), along with groundwater samples. Data from 1996 to 1997 seep/sediment monitoring (Rounds 7 through 10) were used to provide an indication of general chemical concentrations in the intertidal area and were used as part of data evaluation activities for the RI.
Site Screening Investigation (SSI) (Tetra Tech, 2000a)	1998	Conducted to document the release or potential release of hazardous substances that may be present, to make recommendations for further action (e.g., an RI), and to eliminate from further investigation those portions of the site that may pose no appreciable risk to the environment or human health. Based on the chemical concentrations in surface and subsurface soil and groundwater samples, the SSI concluded that additional investigation was necessary, and an RI was conducted.
Multi Sensor Towed-Array Detection System (MTADS) (Naval Research Laboratory, 2001)	1998	Conducted to generate geophysical maps of Jamaica Island (OU3, located east of OU7) and OU7 to identify ferrous or steel-reinforced concrete containers that may have been used to dispose of materials. Conducted on the approximately one-fourth to one-third of OU7 that was accessible to identify magnetic and electromagnetic anomalies. The portions of the site not surveyed were inaccessible because of equipment, fenced laydown areas, railroad tracks, and other structures. The MTADS showed buried utility lines throughout the OU7 area, but an anomaly in the southeastern corner of the survey did not correlate to site features (e.g., utilities). Based on historical figures, a railroad previously ran near the location of the anomaly (north of Goodrich Avenue), and utilities were previously located around the anomaly. Although it was likely that this anomaly was associated with former railroad tracks or utilities, the exact nature was unknown. To rule out that the anomaly could be drums it was investigated further during the RI (Phase I) and no drums were found.
Interim Offshore Monitoring (Tetra Tech, 2004)	1999-2010	Interim offshore monitoring conducted for OU4 that is relevant to OU7 includes data collected for sampling locations MS-03 and MS -04. The Rounds 1 through 7 Report concluded that additional sediment sampling at MS-03 and MS-04 was needed to determine the extent of copper, nickel, and polycyclic aromatic hydrocarbon (PAH) contamination. Foundry slag was noted in offshore areas of OU7 (particularly by MS-04Loc.1 and MS-03Loc.2). Chemical analysis of a sample of the slag (conducted during Round 4) indicated that the slag was approximately 80 percent copper by weight. Other constituents making up the slag included zinc (2 percent by weight), lead (1 percent by weight), and tin and nickel (slightly less than 1 percent by weight).

TABLE 1-1 PREVIOUS INVESTIGATIONS AND SITE DOCUMENTATION		
INVESTIGATION	**DATE**	**ACTIVITIES**
Phase I RI Field Work (Tetra Tech, 2011)	2003	Soil, sediment, groundwater, and intertidal surface water (outfalls and nearby surface water) samples were collected at OU7 to support the nature and extent of contamination and risk assessment. Data were evaluated to determine whether another phase of investigation (Phase II) to support the RI was necessary. Based on the evaluation, it was recommended that one round of groundwater sampling be performed, soil sampling be performed in select areas to define the extent of high chemical concentrations detected, and exploratory borings be advanced to define the extent of potential petroleum contamination.
Site 32 Shoreline Stabilization (Tt EC, 2008)	2006	In June 2006, the Navy conducted an emergency removal action along the shoreline of OU7 to address erosion north of Building 306. Based on the presence of eroding debris, including foundry slag, the Navy removed surface debris and placed a shoreline control (a revetment structure) along the entire OU7 shoreline (approximately 1,200 linear feet) for the purpose of preventing erosion. The controls cover the high- to mid-tide portion of the shoreline and consist of a pea-stone layer to create the necessary grade for an 8-ounce, non-woven, geotextile fabric followed by two layers of graded rock.
Phase II RI Field Work (Tetra Tech, 2011)	2008	Collected additional soil samples, and groundwater samples from OU7 wells and upgradient wells at Site 30, and sediment samples from the intertidal areas. Data were determined to sufficiently fill the data needs identified after the Phase I RI sampling event.
Abandonment of TP-MW09 (Arcadia Environmental Technology, 2012)	2012	In March 2012, as part of a Shipyard construction project for former Building H29, TP-MW09 was abandoned in accordance with MEDEP requirements and abandonment information was sent to MEDEP in April 2012.

1.6 OU7 RI REPORT SUMMARY

In 2011, the Navy prepared the OU7 RI Report to assess the nature and extent of contamination and associated risks at Site 32. The following provides a summary of site characteristics, nature and extent of contamination, fate and transport of contamination, results of the risk assessment, and conclusions and recommendations as provided in the OU7 RI Report (Tetra Tech, 2011).

Elevations discussed herein and throughout this FS are based on the 2002 PNS Vertical Datum and Control Network. The 2002 PNS Vertical Datum equates 0 feet in the North American Vertical Datum of 1988 (NAVD88) to 96.78 feet (Civil Consultants, 2002). Horizontal locations are based on the North American Datum (NAD) of 1983, Maine State Plane Coordinate System, West Zone.

1.6.1 Site Characteristics

Site characterization information, including regional and site-specific information on demography, land use, surface features, climatology, surface water, hydrology, ecology, geology, hydrogeology, and evaluation of the shoreline revetment, is provided in Section 3.0 of the OU7 RI Report. Information on site characteristics was used in the RI to support the evaluation of the nature and extent of contamination, development of the conceptual site model, and understanding potential site risks. The following provides a brief summary of pertinent information reported in the OU7 RI Report.

1.6.1.1 Demography and Land Use

PNS has approximately 90 officers and enlisted personnel and about 3,900 civilian employees (PNS, 2007). Kittery, Maine, is a residential community of 4,562 people, and Portsmouth, New Hampshire, has a population of approximately 21,000 (based on the 2010 Census). Area industries include retail and wholesale trades, textiles, manufacturing, fishing, shipbuilding, power plants, and gas storage facilities. The countryside north and west of Kittery consists of forests and some farmland. Along the coast south of Portsmouth are small communities and seasonal dwellings.

A portion of PNS is on the National Register of Historic Places; however, there are no historical buildings within OU7. The entirety of OU7 is a low-sensitivity area in terms of potential prehistoric and historic archaeological resource sensitivities, as defined by the Cultural Resources Survey (Louis Berger Group, Inc., 2003). Therefore, historical and archaeological considerations are not relevant for OU7.

OU7 use has been and is currently, industrial since the early 1900s, and also currently includes recreational use in the intertidal area (boat pier). The site is covered with pavement or buildings, with some small areas of grass landscaping. A boat ramp by the former Topeka Pier provides access to the intertidal area. Access to the intertidal area from other portions of OU7 is more difficult because of the steeper slope and rip rap along the mid- to high-tide portion of the shoreline. Building H23, located within the limits of OU7, is a hotel which the Navy considers transient housing as opposed to temporary housing where families would stay for several years. Building H23 is not a military or long-term residence.

1.6.1.2 Physical Characteristics

The elevation in the southernmost area near Building 158 is approximately 114 feet. The elevation decreases as you move north across OU7 where the site meets the shoreline. OU7 is relatively flat from east to west, with an average elevation of 105 feet. Refer to Figure 1-3 for the location of Building 158, Back Channel, Goodrich Avenue, the boat ramp, and area contouring.

Climatology indicates precipitation is evenly distributed with 3 to 5 inches falling per month, with snowfall mainly during November to April and rain May to October. Temperatures are moderate, 20 to 40 degrees Fahrenheit (°F) in November to April and 50 to 70 °F in May to October.

1.6.1.3 Surface Water and Hydrology

Portsmouth Harbor's main channel is approximately 75 feet below mean low water (MLW), and the Back Channel is approximately 20 feet below MLW in the vicinity of Seavey Island. The salinity of the surface water exceeds 20 parts per thousand (ppt), and surface water in the area is not suitable for drinking. Commercial and recreational boating and lobstering activities are conducted in the Back Channel in the general vicinity of OU7. Semi-diurnal tides are in the Piscataqua River and Back Channel, and the mean tidal range is 8.1 feet. There are strong currents in the Piscataqua River and Back Channel.

PNS is a well-developed, highly industrialized area with limited natural surface water drainage. PNS is equipped with an extensive stormwater collection system that drains to the Piscataqua River. The storm sewer outfalls in the OU7 intertidal area are tidally influenced, and it is likely that the outfalls are points where groundwater from the site is being transported to the Back Channel. Direct surface water runoff also enters the Piscataqua River. Based on a flood zone map for the PNS area, the 100-year flood zone in the vicinity of OU7 is at an elevation of 105 feet, and a portion of OU7 is between the 100-year and 500-year coastal flood zone (FEMA, 1986). The shoreline of OU7 is at an elevation of approximately 105 feet.

1.6.1.4 Ecology

OU7 is mostly paved or covered with buildings. There is a narrow grassy area along the shoreline to the north and some smaller grassy medians with few trees near the edges of the site. OU7 provides limited habitat for some ecological receptors.

No known endangered, threatened, or protected species or critical habitats are located within the boundaries of PNS, including OU7. PNS is not included in the critical habitats of any species (Maine Fisheries and Wildlife, 1989; NFEC, 1993). The short-nosed sturgeon is a federally endangered species found along the eastern seaboard, but has no critical habitats located within the State of Maine. Populations in Maine are found in the Sheepscot, Kennebeck, Androscoggin, and Penobscot Rivers, and Merrymeeting Bay (Maine Department of Inland Fisheries and Wildlife, 2003).

The OU7 offshore area is within the Back Channel Area of Concern (AOC) of OU4. Intertidal mudflats are generally muddy-sand or sandy-mud areas fringing the shoreline. Mudflats and riprap are present in the intertidal area. Intertidal mudflats are present in the low-tide area and the pelagic and channel bottom/subtidal areas are further offshore in the Back Channel. The shoreline revetment (riprap in high-to mid-tide area) was placed in a rocky intertidal area. No eel grass or saltmarsh is present.

As part of the Phase I RI, a wetland functions and values assessment was conducted in 2003 for the intertidal area of OU7 following the New England District of the United States Army Corps of Engineer's procedure termed the "Highway Methodology." The assessment is included in Appendix A.7 of the OU7 RI Report. The wetland resources associated with the OU7 study area, as of 2003, exhibit moderate value. The three principal factors influencing the lower value of the wetlands include: (1) dense development of the surrounding area; (2) presence of fill materials and rip-rap within the historical tidal area; and (3) altered local, natural hydrologic regime (e.g., flow obstructions/constructions from docks, loss of creeks, and rip-rap/fill).

1.6.1.5 Geology

The current coastline and topography of OU7 were created by using fill material (from approximately 1900 to 1945). The surface of OU7 is covered by surface fill consisting principally of sand with gravel, angular rock fragments, and silt. Debris material was found throughout the site intermingled with the surface fill. A few localized pockets of debris with little soil were encountered in the central portion of the site. Based on observations of shoreline erosion prior to the 2006 shoreline controls construction, subsurface debris extends to the shoreline and is now covered by shoreline controls.

Fill material was encountered from the ground surface to a maximum depth of approximately 23 feet below ground surface (bgs) (TP-SB118), but fill material is present across OU7 to varying depths. The bedrock surface was determined to generally slope to the north and east toward the Back Channel. Bedrock depths varied from 5 to 60 feet. Bedrock is 5 feet bgs to the southwest of the site near Building 184 and is deepest (approximately 60 feet bgs) at TP-SB11.

Subsurface materials at OU7 include the following (from deep to shallow): bedrock; sand, silt, and clay with shell fragments; and surface fill, surface fill with debris, and/or waste (pockets of debris with little to no soil). The bedrock at OU7 consists of a dark gray or greenish-gray quartzite. Sand, silt, and clay with shell fragments are native glaciomarine sediments that generally overlie the bedrock. The fill material (referred to in the following sections as surface fill or surface fill with debris) consists of large angular rock fragments, silt, sand, and gravel. By volume, the majority of the fill material consists of angular rock fragments composed of dark gray, fine-grained quartzite. Debris materials within the surface fill include slag, ash, metal, cinders, coal clinkers, wood, plastic, glass, concrete, porcelain, and brick, depending on the location at the site. Boring logs and cross-sections provided in the OU7 RI Report do not indicate municipal or industrial waste in the fill material. Waste at OU7, as referenced, in the RI Report, was considered where there was a pocket of concentrated debris. A few localized pockets of subsurface waste (concentrated debris) were found in the central portion of the site, but the amount of waste and surface fill with debris is negligible by volume compared to the volume of surface fill.

1.6.1.6 Hydrogeology

Groundwater is encountered within both unconsolidated materials and bedrock at PNS. In general, overburden materials are moderately to highly permeable, and bedrock permeability is generally less than that of unconsolidated materials. Groundwater in bedrock occurs principally in fractures that intersect and enable groundwater to potentially travel in various directions. Near the bedrock surface, fractures are pervasive because of weathering of the rock. The size and interconnectedness of the fractures generally decrease with depth, potentially limiting the movement of groundwater.

Groundwater levels in overburden at PNS are shallow, and groundwater flow directions generally mimic topography and are influenced by the thickness and composition of the overburden and tidal fluctuation. Overall, groundwater flow directions are from the original island interior toward the current coastline.

At the time the RI was conducted, a total of 19 groundwater monitoring wells existed in and around OU7 (as shown on Figure 1-3), of which 14 are located within the OU7 boundary (FA-01, FA-01B, FA-01DB, TP-MW02, TP-MW03, TP-MW04, TP-MW05, TP-MW06, TP-MW07, TP-MW08, TP-MW09, TP-MW10, TP-MW11, TP-MW12). Five wells are located upgradient of the OU7 boundary, including four located southwest of OU7 near Building 184 (B184-MW01, B184-MW02, B184-MW03, B184-MW04) and one located south of the timber basin area (TP-MW01). Table 3-1 in the RI Report lists well construction details for the existing wells at OU7. OU7 monitoring wells range in total depth from 13 to 157.5 feet bgs and are screened in fill only, bedrock only, overburden only, overburden and bedrock, and fill and overburden. Screen lengths included 7, 10, 15, and 20 feet and were selected based on the lithologies encountered and anticipated tidal fluctuations. Specific details concerning construction of the groundwater monitoring wells and hydraulic conductivity testing are provided in Appendix A of the OU7 RI Report (Tetra Tech, 2011). TP-MW09 was abandoned in 2012.

The shallow groundwater at OU7 is brackish with a salinity lower than the Back Channel, which has a salinity in excess of 20 ppt. Brackish water is considered to have a salinity between 0.5 and 30 ppt. Fresh water has a salinity of less than 0.5 ppt, and sea water has a salinity of greater than 30 ppt. Salinity of groundwater within OU7 (located outside the original island boundary) ranges from approximately 3 to 26 ppt, an average of approximately 20 ppt, based on the Phase II RI field water quality measurements. In contrast, the salinity of groundwater upgradient of OU7 (located within the original island boundary) ranges from approximately 0.28 (B184-MW01) to 1.4 ppt (TP-MW01). Groundwater in bedrock is also brackish, based on water quality at the FA-01 well cluster. Saline and brackish water are not potable.

The hydrogeology of OU7 is consistent with the predominantly filled nature of the area. Tidal influence is strong across much of the site, especially at groundwater monitoring wells near the current coastline. All wells within the OU7 boundary are tidally influenced, aside from TP-MW09, FA-01B, and FA-01DB. FA-01B and FA-01DB are both screened in the bedrock, well below the fill. The upgradient monitoring wells (Site 30 wells and TP-MW01) are not tidally influenced. The upgradient wells are located outside of the 1880 shoreline, which is equivalent to the OU7 boundary. During low tides, the depth to groundwater is approximately 10 feet bgs in the most tidally influenced monitoring wells near the coastline of OU7, while it is as little as 4 feet bgs in the upgradient wells to the south. At high tides, depths to groundwater range between 3 and 7 feet bgs in the most tidally influenced monitoring wells near the coastline of OU7, while there is little change in the upgradient wells to the south. At low tide, groundwater flows from the interior of the island toward the coastline, roughly northward. There appears to be some channelized flow along the location of a stormwater discharge pipe that runs from near TP-MW02 north to TP-MW04. At high tide, groundwater flow direction reverses near the shoreline, and flows south to a low trough that runs east to west along the southern boundary of OU7. This flow is met by groundwater flowing north from the interior of the island. This trough appears to have a low point between TP-MW10 and TP-MW11.

1.6.2 Nature and Extent of Contamination

The discussion of the nature and extent of contamination at OU7 focuses on the distribution of chemical concentrations across OU7 with consideration of site uses and geological conditions. For the onshore area, soil and groundwater were investigated, and for the offshore area, surface water, seeps, and sediment were investigated.

Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, dioxins/furans, and inorganics were detected in the surface soil and subsurface soil at OU7. Concentrations in the subsurface soil were generally greater than in the surface soil. Based on an evaluation of carcinogenic PAHs [expressed in terms of benzo(a)pyrene (BAP) toxicity equivalency quotient (TEQ)], dioxins/furans [expressed as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) TEQ], and copper concentrations, locations where risk-based screening levels were exceeded correspond to areas where fill activities took place after 1910, with the exception of TP-SB120, TP-SB15, and TP-SB39. From evaluation of the data, approximately one-half of the locations where concentrations were indicated to be above background levels, debris material was found; therefore, the presence of debris material would not delineate contamination. The borings in the area filled before 1910, in the vicinity of former Building 237, neither contain debris material nor have concentrations greater than risk-based screening levels for total polychlorinated biphenyls (PCBs), lead, carcinogenic PAHs, and dioxins/furans. A statistical comparison of mean concentrations in the area without the debris to the mean concentrations in the rest of OU7, demonstrates that the mean concentrations in the filled area before 1910 in the vicinity of former Building 237, are statistically different than the rest of OU7. Therefore, the filled area in the immediate vicinity of former Building 237 can be defined as a separate population from the rest of OU7. Contaminated material and debris extend to the shoreline and are covered by shoreline controls (Figure 1-4).

PAHs and inorganics were detected in groundwater at OU7, whereas VOCs, pesticides, and PCBs were not detected in any groundwater sample. Aluminum, copper, and manganese were detected in fewer than four samples at concentrations exceeding the risk-based screening levels. The groundwater at OU7 is saline/brackish and not potable.

Inorganics were the only chemicals detected in OU7 surface water but were detected at concentrations less than the risk-based screening levels. SVOCs, pesticides, PCBs, and inorganics were detected in OU7 seep samples. Arsenic and chromium were the only chemicals detected at concentrations exceeding human health risk-based screening levels in these samples. Benzo(b)fluoranthene, chrysene, dichlorodiphenyldiethylene (4,4-DDE), dichlorodiphenyltrichloroethane (4,4-DDT), heptachlor, and heptachlor epoxide were detected at concentrations exceeding ecological risk-based screening levels.

SVOCs, pesticides/PCBs, and inorganics were detected in OU7 sediment. PAHs, PCBs, and inorganics were detected at concentrations exceeding human health risk-based screening levels in these samples, and anthracene, fluorene, copper, and nickel were detected at concentrations greater than the ecological risk-based screening levels. The extent of sediment contamination is bounded.

In summary, OU7 is a large filled area (approximately 19 acres) consisting principally of sand with gravel, angular rock fragments, and silt mixed with some debris. There are a few intermittent pockets of debris with little to no soil. There are generally low levels of contamination found within the OU7 fill material. Areas of higher contaminant concentrations compared to the rest of the site (specifically dioxin/furans and PCBs) were found in the former timber basin area. Contaminated material and debris within the fill extend to the shoreline and are covered by the existing shoreline controls.

1.6.3 Fate and Transport of Contaminants

OU7 surface is mostly covered with asphalt/pavement, limiting mobilization of contaminants through surface water runoff or infiltration of precipitation. The site was filled over 50 years ago with mostly rock and soil. Much of the subsurface soil is in contact with groundwater. Three rounds of groundwater data (collected from 1998 to 2008), intertidal surface water data, and sediment data along with modeling were used to evaluate the fate and transport of OU7 contaminants in soil to other media which is summarized as follows.

The contaminants found in the fill placed on the site over 50 years ago would not cause any new or sudden releases that would adversely affect groundwater. For example, the mobility of PAHs via the groundwater pathway at OU7 is not considered significant because PAHs were infrequently detected in groundwater and at levels several orders of magnitude less than the risk-based screening levels. PCBs were not detected in groundwater, indicating no vertical movement of these contaminants from soil to groundwater. Data for OU7 do not indicate significant concentrations of dioxins/furans that would facilitate movement of these contaminants. Furthermore, dioxins/furans do not dissolve easily in water and will partition strongly to soil, sediment, or organic matter and are generally immobile in soil and sediment. The fate and transport of inorganics are controlled mainly by the mobility of soil particles and dissolution into water present in their immediate environment. The mobility of metals under strong acidic or alkaline conditions is expected to be limited at OU7 because of the buffering action of brackish/saline groundwater. The major fate mechanisms for OU7 contaminants are adsorption to the soil matrix and bioaccumulation. Only a small portion of OU7 is covered with flora, so exposure for herbivores feeding on the vegetation affected by bioaccumulation is not a concern.

Contaminant fate and transport modeling was conducted to conservatively estimate potential migration of contamination from soil to groundwater and then to intertidal sediment and near-shore surface water. Detailed results of the modeling are presented in Appendix C of the RI Report (Tetra Tech, 2011). The modeling assumed that the pavement at OU7 was removed; that the amount of infiltrating precipitation coming in contact with soil would be greatly increased compared to current conditions; and that the overall groundwater flow conditions and contributions from storm water sewer discharge would not change significantly in the future. The modeling results using unsteady state and steady state parameters indicate that surface water is not being and would not in the future be adversely impacted by onshore sources of contamination. Using unsteady state parameters, the modeling conservatively indicates that sediment may potentially be impacted through the onshore migration of metals contamination through groundwater. Using steady state parameters, the modeled impacts to sediment do not appear to be high compared to sediment criteria. Observed concentrations of metals in sediment are orders of magnitude less than the modeled results and do not indicate groundwater migration is adversely impacting sediment.

Shoreline stabilization was conducted in June 2006 to prevent contaminated soil and debris from eroding. Current conditions indicate that no further erosion is occurring. The long-term stability and functioning of the shoreline controls are necessary to ensure that future erosion does not occur. Therefore, if the shoreline erosion controls fail, there is a potential for contaminant migration through shoreline erosion to the offshore area.

1.6.4 Risk Assessment Summary

As discussed in Section 6.0 of the OU7 RI Report (Tetra Tech, 2011), analytical data for soil, intertidal water (i.e., combined seep and surface water), intertidal sediment, and groundwater were used in the human health risk assessment (HHRA) for OU7. The receptors and exposure routes evaluated are summarized in Table 1-2.

TABLE 1-2 RECEPTORS AND EXPOSURE ROUTES EVALUATED IN HHRA

RECEPTOR	EXPOSURE ROUTE
Construction Worker (current/future)	Soil Ingestion - (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil) Dermal Contact with Groundwater
Occupational Worker (current/future)	Soil Ingestion (surface and subsurface soil)* Soil Dermal Contact (surface and subsurface soil)* Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)*
Recreational User (current/future)	Soil Ingestion (surface and subsurface soil)* Soil Dermal Contact (surface and subsurface soil)* Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)* Ingestion of and Dermal contact with sediment and intertidal surface water.
Resident (future)	Soil Ingestion (surface and subsurface soil) Soil Dermal Contact (surface and subsurface soil) Inhalation of Air/Dust Particulates and Vapors (surface and subsurface soil)

* Although occupational workers and recreational users are current receptors at OU7, there is no current exposure route to surface or subsurface soil for these receptors; therefore, risks for these receptors were evaluated as future potential risks.

Current receptors that do not have a current exposure route were evaluated under future risks only. Building H23 at OU7 is a hotel named the Navy Gateway Inns and Suites (NGIS), which the Navy considers transient housing as opposed to temporary housing where military families would stay for several years. Hotel receptors would have far less exposure to potentially contaminated soil, if any, than residential receptors; therefore, potential hotel receptors were not considered residential receptors and residential receptors were not evaluated as a current receptor. Current potential risks for exposure to media in the intertidal area of OU7 for occupational workers or hotel guests staying at Building H23 were evaluated under the current recreational user scenario. Potential risks for exposure to subsurface soil that could be excavated and become surface soil were evaluated as part of the uncertainty analysis. The HHRA evaluated potential risks under current land use conditions and potential future land use conditions for the entire site, and separately for the area filled before 1910 where no debris was found. No chemicals of potential concern (COPCs) were identified for surface water; therefore, a quantitative evaluation for recreational exposure to surface water was not required. Potentially unacceptable non-carcinogenic health effects were identified for receptors with hazard indices (HIs) greater than 1 (the USEPA target risk level and State of Maine risk guideline). Potentially unacceptable carcinogenic health effects were identified for receptors with incremental lifetime cancer risks (ILCRs) exceeding the USEPA target risk range ($1x10^{-6}$ to $1x10^{-4}$) and the State of Maine risk guideline ($1x10^{-5}$). The State of Maine risk guideline is not a regulatory requirement and will not be used for identifying cleanup goals.

Potentially unacceptable, non-carcinogenic health effects are not anticipated for occupational workers exposed to surface soil, residents exposed to surface soil, or recreational users exposed to surface soil and sediment because reasonable maximum exposure (RME) and central tendency exposure (CTE) scenario HIs are less than or equal to 1. Risks were also acceptable for construction worker exposure to groundwater. Potentially unacceptable, non-carcinogenic health effects are not anticipated for occupational workers, recreational users, and residents exposed to surface soil in the area with no debris in the vicinity of former Building 237 because RME and CTE scenario HIs were less than 1. RME and CTE HIs were less than 1 for construction workers exposed to entire site surface soil and surface soil and subsurface soil in the area with no debris. RME and CTE HIs are greater than 1 for construction workers exposed to all site soils (surface and subsurface soil combined), and dioxins/furans (based on 2,3,7,8-TCDD TEQ) in subsurface soil are the main risk contributor to those exposure scenarios. For the uncertainty evaluation of occupational worker, recreational user, and residential exposure to subsurface soil, the results showed that HIs would be greater than 1 for occupational workers and residents with dioxins/furans (based on 2,3,7,8-TCDD TEQ) being the main risk driver for occupational workers and dioxins/furans, antimony, copper, and iron being the main risk drivers for residents. HIs for recreational users exposed to subsurface soil were less than or equal to 1 under RME and CTE scenarios. RME and CTE HIs were less than 1 for occupational workers, recreational users, and residents exposed to subsurface soil in the area with no debris.

RME and CTE cancer risk estimates for construction workers exposed to surface and subsurface soil, recreational users exposed to surface soil and sediment, occupational workers exposed to surface soil, and residents exposed to surface soil are less than or within the USEPA target cancer risk range ($1x10^{-6}$ to $1x10^{-4}$). The RME cancer risks for adult residents ($2x10^{-5}$), child residents ($1x10^{-4}$) and lifetime residents ($1x10^{-4}$) exposed to surface soil exceed the State of Maine risk guideline of $1x10^{-5}$. CTE cancer risk estimates did not exceed the State of Maine risk guideline. Residential risks exceeding the State of Maine risk guideline in surface soil are primarily due to carcinogenic PAHs. For the uncertainty evaluation of occupational worker, recreational user, and residential exposure to subsurface soil, the results showed that cancer risks would exceed the USEPA target risk range for a child and adult resident, where the main risk contributors are carcinogenic PAHs, PCBs (Aroclor 1248 and Aroclor 1260), and dioxins/furans. Results for all receptors evaluated for exposures to surface soil and subsurface soil in the area with no debris were less than or within the USEPA target cancer risk range.

Results of the lead evaluations indicate that adverse effects are not likely for occupational workers, construction workers, or recreational users exposed to lead in soil. However, the results indicate that adverse effects may occur for future residents exposed to surface soil or subsurface soil.

The site is currently and has historically been located within an industrial area of PNS, and no ecological habitat has been identified at the site. Therefore, there are no onshore concerns for ecological risk. Offshore concerns for ecological receptors are being addressed as part of OU4. OU7 is no longer acting as a source of contaminants that may pose unacceptable risk to the offshore area.

1.6.5 Conclusions and Recommendations of RI

Based on the RI, the site boundary of OU7 is defined by the historical fill lines. The nature and extent of contamination in soil at OU7 has been sufficiently defined to support the FS. Potentially unacceptable risks were found for the current and future construction worker exposed to subsurface soil, for the future resident exposed to surface soil, and the resident and occupational worker exposed to subsurface soil. Based on the risk assessment in the RI Report, the chemicals of concern (COCs) for OU7 are dioxins/furans, carcinogenic PAHs, total PCBs (based on total PCBs as Aroclors), antimony, copper, iron, lead, and manganese. Total PCBs were retained as subsurface soil risk drivers due to elevated concentrations detected in a localized area (at locations TB-SB108 and TP-SB14). Based on the risk evaluation, groundwater, surface water, and sediment are not media of concern for OU7.

The fill area prior to 1910 in the vicinity of former Building 237 was determined to have statistically different mean concentrations than the rest of OU7, adverse human health risks were not found for this area, and the extent of contamination was bounded.

Groundwater, surface water, sediment, and soil data from OU7 and modeling conclusions show that migration of contaminants in groundwater from OU7 to the offshore does not pose a current risk and would not pose a future risk.

Shoreline stabilization was conducted in June 2006 to prevent contaminated soil and debris from eroding. Current conditions indicate no further erosion is occurring. However, long-term stability and functioning of the shoreline controls are necessary to ensure future erosion does not occur. Therefore, there is a potential future risk to the offshore area from erosion if erosion controls failed.

Although the HHRA evaluated risks based on site areas, PRGs should be developed and applied to the appropriate exposure units across OU7 to determine the remediation areas in the FS. Industrial and residential exposure units should reflect current and likely future land uses.

1.7 SUMMARY OF CONCEPTUAL SITE MODEL

The following is a summary of the OU7 conceptual site model (also see Figure 1-5) which includes a description of the site, potential receptors, contamination sources, and potential migration routes. OU7 is covered with pavement or buildings, with some small areas of grass landscaping. A boat ramp near the former Topeka Pier provides access to the intertidal area. Access to the intertidal area from other portions of OU7 is more difficult because of the steeper slope and large rocks and boulders on the upper portion of the shoreline. Current onshore land use for OU7 is industrial with recreational use in the intertidal area (boat pier). The site uses are likely to remain as they are currently. However, unrestricted residential, recreational, or industrial use of the site may be possible future scenarios if the Shipyard were to close. Sufficient habitat at OU7 is not available for ecological receptors at OU7; therefore, onsite ecological exposure is not considered significant.

Primary sources of contamination at OU7 are from past filling activities (from approximately 1900 to 1945) conducted to extend the shoreline and industrial use of the site (including a former timber basin). The fill material is mostly rock and soil, intermingled with some debris. There are a few intermittent pockets of debris with little soil. Fill material and debris within the fill material extend to the shoreline and are covered by the existing shoreline controls. Generally low levels of contamination were found within the OU7 fill material. Several areas of higher contaminant concentrations compared to the rest of the site (specifically dioxins/furans and PCBs) were found in the former timber basin area. This area includes sample locations TP-SB27, TP-SB112, and TP-SB14/TP-SB108. However, municipal or industrial waste or high-level contamination across the site was not found.

Evaluation of potential risks for people who may be exposed to chemicals in surface or subsurface material or groundwater at OU7 or surface water or sediment in the intertidal area indicated that the only potentially unacceptable risks were for hypothetical future residential exposure to surface or subsurface soil and industrial user (construction or occupational worker) exposure to subsurface soil.

Potential contaminant migration from fill material through groundwater transport, including through sediment, seeps, and the storm sewer system is not a current and would not be a future unacceptable risk. Three rounds of groundwater monitoring conducted between 1998 and 2008 and contaminate fate and transport modeling for OU7 indicated that inorganics and organics are not leaching from soil to groundwater at concentrations that would adversely impact human health or the environment. Fill material, placed over 50 years ago, has been in contact with groundwater and it is not likely that there would be any new or sudden contaminant releases from soil to groundwater. Potential contaminant migration pathways from fill material to the offshore from future erosion of the shoreline if shoreline controls were to fail is considered a future potential unacceptable risk.

Based on the potential current or future risks for OU7, surface soil and subsurface soil are the media of concern. Groundwater and intertidal sediment and surface water are not media of concern for OU7. Table 1-3 provides a summary of the soil COCs that are contributing to potentially unacceptable risks for receptors exposed to soil.

TABLE 1-3 SUMMARY OF SOIL COCS AND EPCS

Receptor	Media	COC	EPC for Entire Site(1) (mg/kg)	EPC for Entire Site Except Samples in the Vicinity of Former Building 237(1) (mg/kg)
Industrial Worker (2)(3)	Subsurface Soil	Dioxins/Furans (4)	0.0013	0.0014
		Total PCBs	6.3	6.5
Hypothetical Future Resident (3)	Surface Soil	Lead	510	582
	Subsurface Soil	Carcinogenic PAHs (4)	1.1	0.85
		Dioxins/Furans (4)	0.0013	0.0014
		Total PCBs	6.3	6.5
		Antimony	182	281
		Copper	6,020	6,170
		Iron	97,100	98,900
		Lead	1,600	1,630

mg/kg – milligram per kilogram

(1) Data sets are described in Appendix A.2.

(2) The industrial worker includes the construction worker and occupational worker. Manganese, initially identified as a COC for the construction worker for subsurface soil is not shown as discussed further in Section 2.4.

(3) Not current exposure scenario for occupational worker or resident because site is covered with pavement and site is not used for residential use.

(4) Dioxins/furans are evaluated based on 2,3,7,8-TCDD TEQs and carcinogenic PAHs are evaluated based on BAP TEQs.

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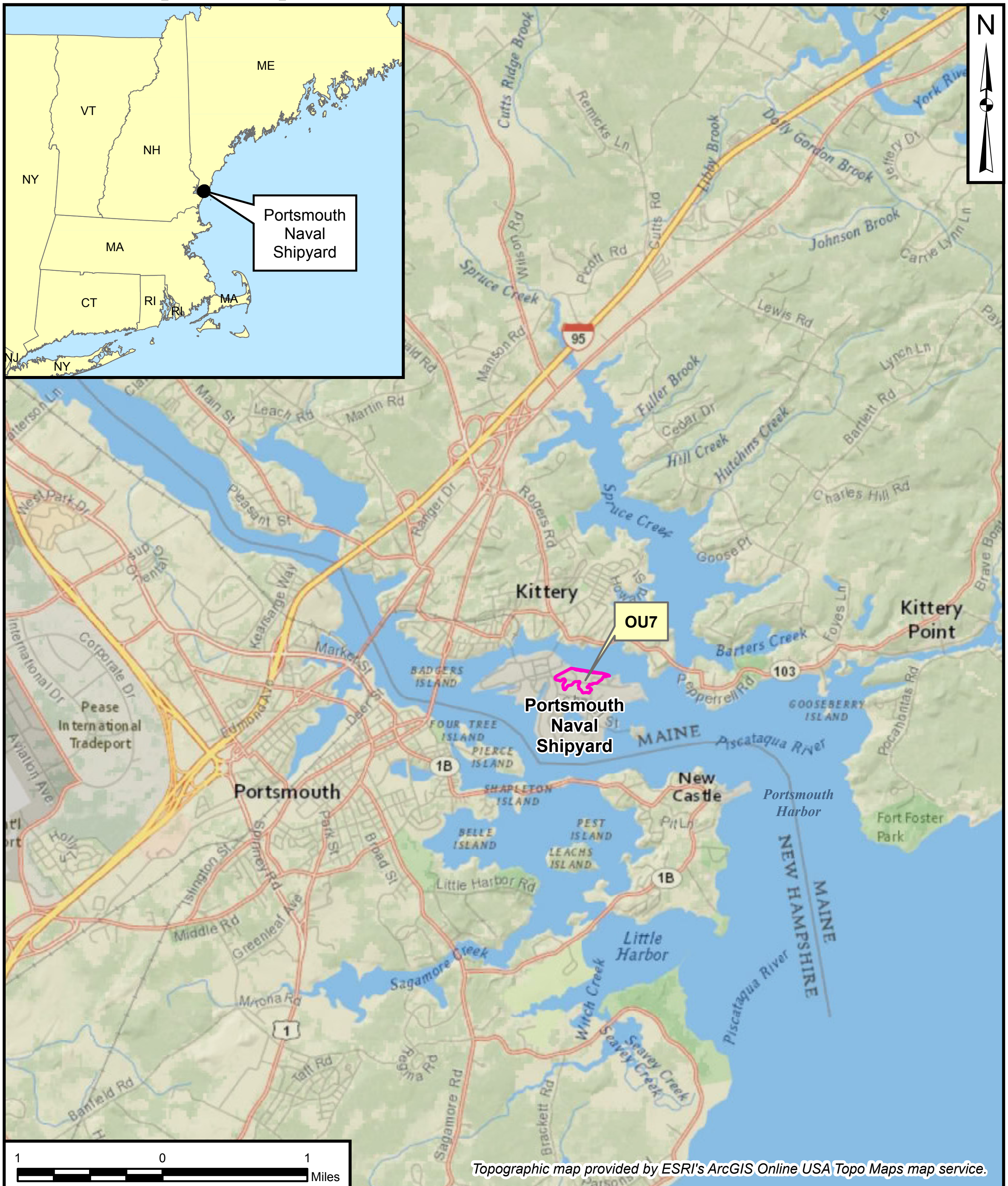

DRAWN BY K. MOORE	DATE 04/03/12	TETRA TECH	CONTRACT NUMBER 2100	CTO NUMBER WE13
CHECKED BY M. KRAUS	DATE 05/15/12	VICINITY AND LOCATION MAP OPERABLE UNIT 7 PORTSMOUTH NAVAL SHIPYARD KITTERY, MAINE	APPROVED BY ___	DATE ___
REVISED BY ___	DATE ___		APPROVED BY ___	DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE 1-1	REV 0

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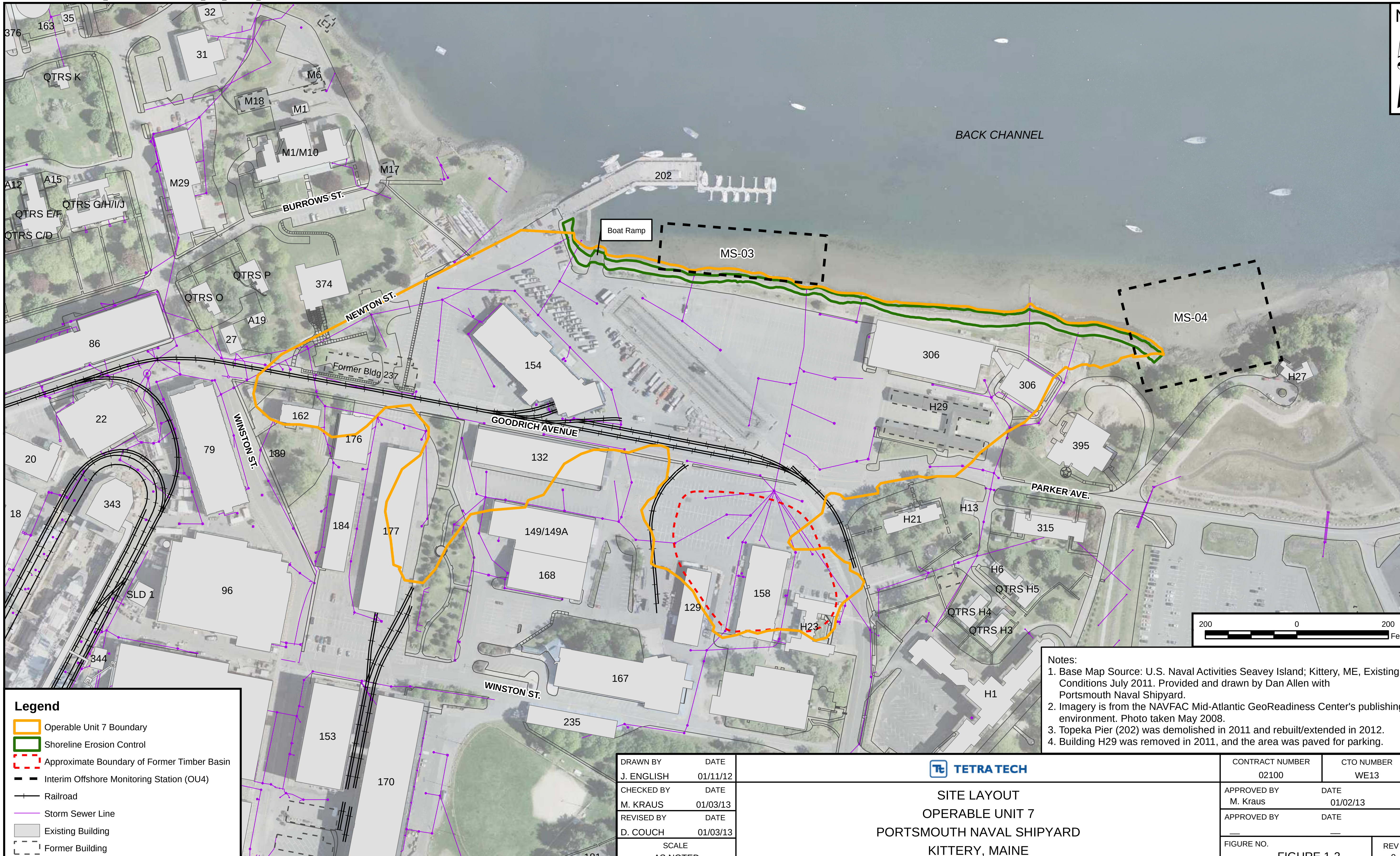

Legend

- Operable Unit 7 Boundary
- Shoreline Erosion Control
- Approximate Boundary of Former Timber Basin
- Interim Offshore Monitoring Station (OU4)
- Railroad
- Storm Sewer Line
- Existing Building
- Former Building

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Imagery is from the NAVFAC Mid-Atlantic GeoReadiness Center's publishing environment. Photo taken May 2008.
3. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.
4. Building H29 was removed in 2011, and the area was paved for parking.

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	01/11/12		02100	WE13
CHECKED BY	DATE	SITE LAYOUT	APPROVED BY	DATE
M. KRAUS	01/03/13	OPERABLE UNIT 7	M. Kraus	01/02/13
REVISED BY	DATE	PORTSMOUTH NAVAL SHIPYARD	APPROVED BY	DATE
D. COUCH	01/03/13	KITTERY, MAINE	—	—
SCALE			FIGURE NO.	REV
AS NOTED			FIGURE 1-2	0

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Legend

- OU7 (Site 32) Monitoring Well
- Site 30 Monitoring Well
- Soil Boring
- Road
- Railroad
- Storm Sewer
- Shoreline Erosion Control
- Operable Unit 7 Boundary
- Building
- Former Building
- Topographic Contour (1-foot interval)

Notes:

1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Vertical datum for topographic contours is PNS 2002 Datum.
3. Topeka Pire (202) was demolished in 2011 and rebuilt/extended in 2012.

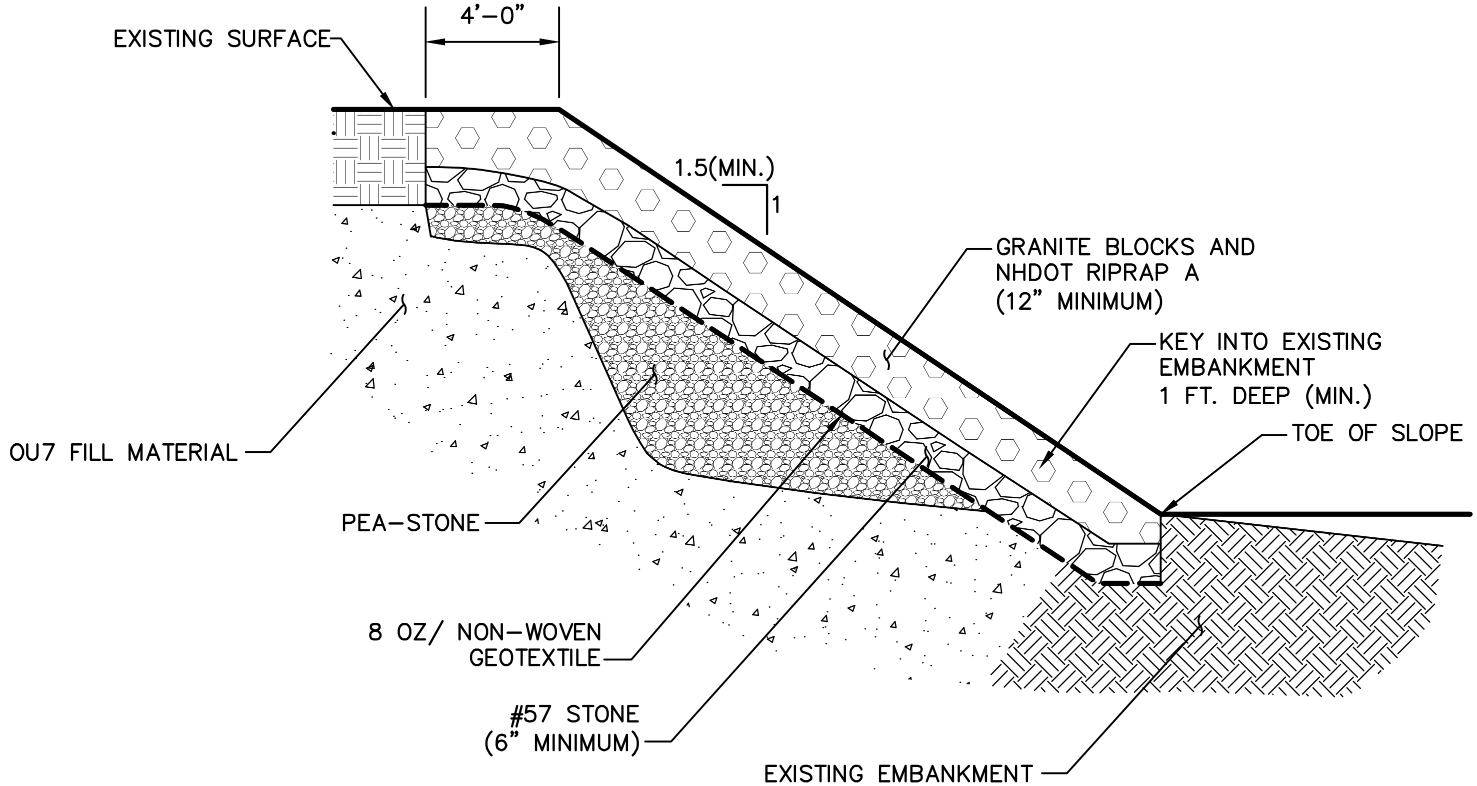
* Well abandoned in 2012

DRAWN BY	DATE
J. ENGLISH	12/29/11
CHECKED BY	DATE
M. KRAUS	01/03/13
REVISED BY	DATE
D. COUCH	01/03/13
SCALE	
AS NOTED	

TETRA TECH

TOPOGRAPHIC MAP AND ONSHORE SAMPLING LOCATIONS
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/02/13
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 1-3	0



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PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

TYPICAL SECTION OF
SHORELINE CONTROLS
OPERABLE UNIT 7

DATE:	5–10–12
PROJECT NO.:	112G02100
DESIGNED BY:	
DRAWN BY:	CK
CHECKED BY:	
SHEET: 1 OF 1	
SIZE: A	FIGURE 1–4

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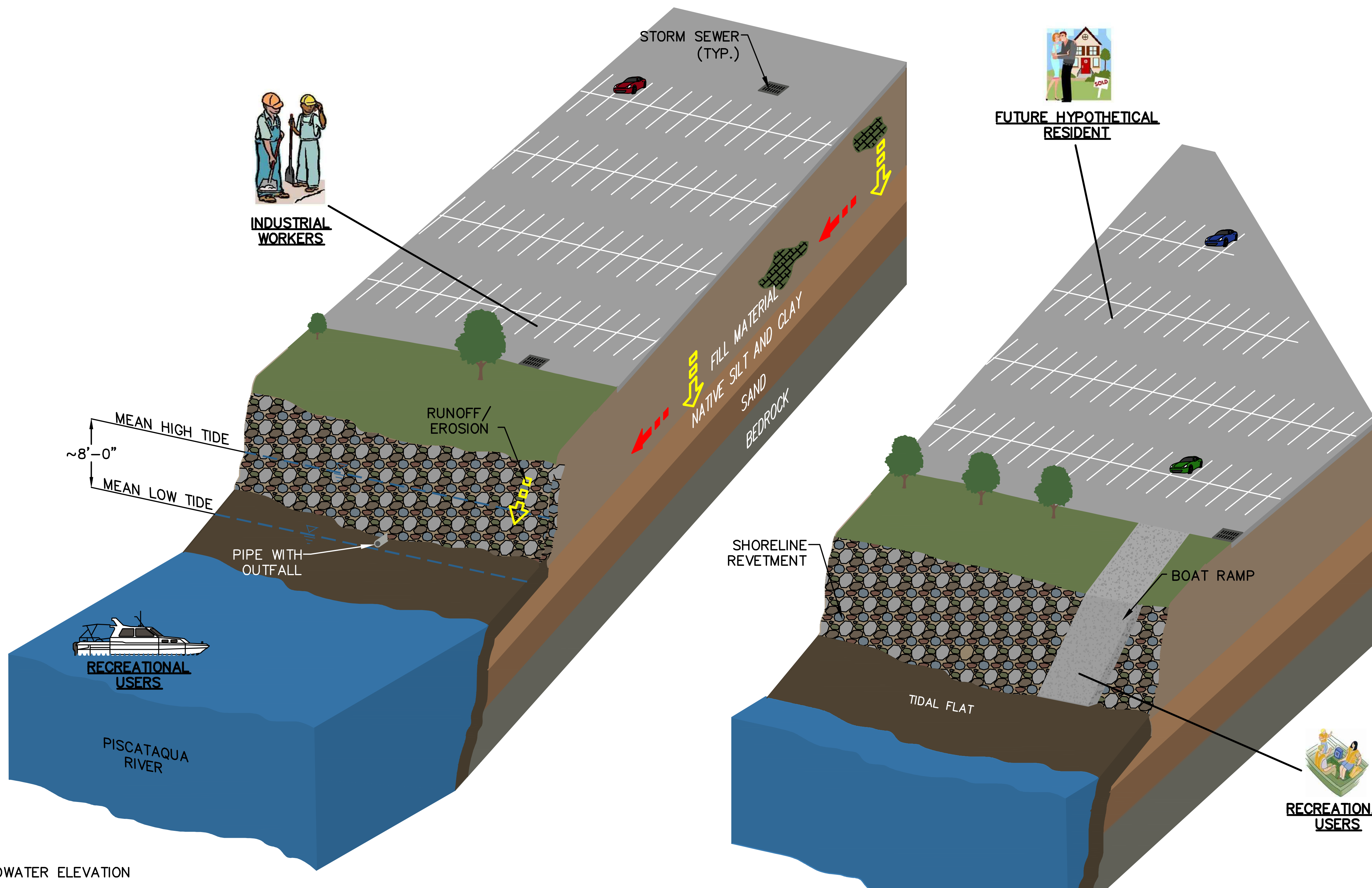

LEGEND:

- GROUNDWATER ELEVATION
- POCKETS OF DEBRIS WITH LITTLE SOIL
- POTENTIAL MIGRATION
- FUTURE MIGRATION
- (TYP.) TYPICAL

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CONCEPTUAL SITE MODEL
OPERABLE UNIT 7

PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

SCALE: NOT TO SCALE

DATE:	01/02/13
PROJECT NO.:	112G02100
DESIGNED BY:	
DRAWN BY:	NN
CHECKED BY:	MK
SHEET:	1 OF 1
SIZE: B	FIGURE 1–5

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2.0 REMEDIAL ACTION OBJECTIVES

This section identifies the ARARs, discusses the media of concern, and develops the RAOs for remedial activities at OU7. ARARs are regulatory requirements and guidance that govern remedial activities. The media of concern at OU7 is defined along with the volume of the contaminated media. RAOs are medium-specific goals that define the objectives of conducting remedial actions and are developed to allow consideration of a range of remedial alternatives developed in subsequent sections.

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

This subsection discusses the federal and state of Maine ARARs and "to be considered" (TBC) criteria for OU7. The two threshold criteria that remedial alternatives must meet are: (1) protection of human health and the environment and (2) compliance with ARARs. Remedial alternatives must attain or exceed conformance with all ARARs unless a waiver of an ARAR is justified, as described further in this section.

ARARs address a chemical, location, or action at a site and are defined as any standard, requirement, criterion, or limitation under federal environmental law, or any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation, and is either legally applicable to the CERCLA hazardous substance(s) at the site, or is relevant and appropriate under the circumstances of the hazardous substance release.

One of the primary concerns during the development of remedial action alternatives for hazardous waste sites under CERCLA is the degree of human health and environmental protection afforded by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent federal and state environmental requirements.

Definitions of ARARs, as well as TBC criteria, are as follows:

- <u>Applicable Requirements</u> are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site [40 Code of Federal Regulations (CFR) §300.5].

- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, although not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site that their use is well suited (appropriate) to the particular site (40 CFR §300.5).

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing remedial action alternatives and for determining action levels that are protective of human health and/or the environment. Examples of TBC criteria include Cancer Slope Factors (CSFs) and Reference Doses (RfDs) (40 CFR §300.5).

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain all ARARs if any of six conditions for a waiver of ARARs exists. These six conditions are as follows: (1) the remedial action is an interim measure, whereby the final remedy will attain the ARAR upon completion; (2) compliance will result in greater risk to human health and the environment than other options; (3) compliance is technically impracticable; (4) an alternative remedial action will attain the equivalent of the ARAR; (5) for state requirements, the state has not consistently applied the requirement in similar circumstances; or (6) compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of fund money for response at other facilities (fund-balancing). The last condition only applies to Superfund-financed actions.

ARARs and TBCs fall into three categories. The characterization of these categories is not conclusive because many requirements are combinations of ARARs and TBCs. These categories are as follows:

- Chemical-Specific: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants within the media of concern.

- Location-Specific: Restrictions based on the concentrations of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Location-specific ARARs and TBCs pertain to special site features, and examples include floodplain and coastal zone requirements.

- Action-Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous substances. Action-specific ARARs and TBCs pertain to implementing a given remedy. Examples are RCRA requirements for management of hazardous waste that may be generated as part of remedial actions.

Potential chemical-specific, location-specific, and action-specific ARARs and TBCs for OU7 are listed in Tables 2-1, 2-2, and 2-3, respectively.

2.2 MEDIA OF CONCERN

The media of concern that pose potential unacceptable risk addressed in this FS are surface and subsurface soil because COCs are present at concentrations that could result in potentially unacceptable risk levels for human health through exposure and also because of the future potential for erosion of onsite soil to the offshore area if shoreline erosion control measures are removed or compromised. Consistent with the OU7 RI Report (Tetra Tech, 2011), there are potentially unacceptable risks for hypothetical future residential receptors exposed to surface soil from 0 to 2 feet bgs and to subsurface soil from 2 to 10 feet bgs (Figure 2-1). There are potentially unacceptable risks for industrial receptors (construction and occupational receptors) exposed to subsurface soil from 2 to 10 feet bgs as shown on Figure 2-2. Soil is also a medium of concern if soil along the shoreline erodes to the offshore area in the future. Based on the risk conclusions, groundwater and intertidal sediment and surface water are not media of concern for OU7. COCs for soil include antimony, copper, dioxins/furans, iron, lead, carcinogenic PAHs, and PCBs. Manganese is not included as a COC as discussed in Section 2.4.

2.3 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals for protecting human health and the environment. RAOs are required to specify the COCs, exposure routes and receptors of concern, and an acceptable contaminant level or range of levels for each exposure route. Acceptable contaminant levels are based on site-specific PRGs as a starting point, after which a final remediation goal is determined when a remedy is selected.

As discussed in Section 1.7, potential human health risk concerns have been identified for certain receptors that may be exposed to soil contaminants at OU7 and future erosion. Based on an understanding of these potential human health and environmental risks, the following RAOs have been developed for OU7:

- Prevent residential exposure through ingestion of, dust inhalation of, and dermal contact with surface soil containing lead, and subsurface soil containing antimony, copper, dioxins/furans, iron, lead, carcinogenic PAH, and PCB concentrations exceeding residential PRGs.

TABLE 2-1: POTENTIAL CHEMICAL-SPECIFIC ARARS AND TBCS				
MEDIUM/ACTIVITY	**REQUIREMENT/CITATION**	**STATUS**	**SYNOPSIS**	**EVALUATION/ACTION TO BE TAKEN**
FEDERAL				
Soil/Risk Assessment	Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12	TBC	USEPA has provided recommended methodology for assessing risk caused by exposure to lead in surface soil under residential scenarios.	Guidelines were used to develop risk-based cleanup goals for lead in soil.
	USEPA RfDs from Integrated Risk Information System (IRIS)	TBC	RfDs are estimates of daily exposure for human populations (including sensitive subpopulations) considered unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure over a lifetime.	RfDs were used to develop risk-based soil cleanup goals for non-carcinogenic COCs, including antimony, copper, dioxins/furans, and iron.
	USEPA Human Health Assessment Group CSFs from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform HHRA. They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
Soil/Risk Assessment	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
STATE				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	These guidelines can be used to develop soil cleanup levels. However, per Section V.H, site-specific risk-based cleanup levels were used for OU7 instead of RAGs table values.

TABLE 2-2: POTENTIAL LOCATION-SPECIFIC ARARS AND TBCS				
REQUIREMENT	**CITATION**	**STATUS**	**SYNOPSIS**	**EVALUATION / ACTION TO BE TAKEN**
FEDERAL				
Coastal Zone Management	Coastal Zone Management Act [16 United States Code (USC) 1451 *et seq*].	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Remedial activities, such as excavation along the shoreline or shoreline control maintenance, that take place in the coastal zone would be controlled according to the requirements of the MEDEP program. MEDEP would review remedial action documents and work plans to ensure that they meet the substantive requirements of this act. The requirements of the act would continue to apply during the operation and maintenance of the remedy.
Wetlands and United States Waters	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230; 33 CFR 320, 322, and 323).	Applicable	These regulations outline the requirements for the discharge of dredged or fill material into US waters, including wetlands. No activity that adversely affects a US waters is permitted if a practicable alternative that has less effect is available. If there is no other practicable alternative, impacts must be mitigated.	Remedial activities, such as excavation along the shoreline or shoreline control maintenance, that are conducted in the river would be performed so as to not impact the offshore area.
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq*.; 50 CFR Parts 17 and 402).	Applicable	Provides for consideration of impacts to endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon is listed as a threatened species	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However, short-nosed and Atlantic sturgeon are present in the Piscataqua River. Remedial activities would be conducted so as to avoid any adverse effect under the Act to these sturgeon.

TABLE 2-2: POTENTIAL LOCATION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION / ACTION TO BE TAKEN
Other Natural Resources	Fish and Wildlife Coordination Act (16 USC 661 *et seq*.)	Applicable	This act requires any federal agency proposing to modify a body of water to coordinate with the United States Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) and appropriate state agencies if alteration of a body of water, including discharge of pollutants into a wetland or construction in a wetland, will occur as a result of offsite remedial activities.	For activities such as excavation along the shoreline or shoreline control maintenance that may impact the coastal floodplain and river, the Navy would coordinate with USFWS in the event that the remedy disturbs these areas.
Floodplain Management and Protection of Wetlands	44 CFR 9	Relevant and Appropriate	Federal Emergency Management Agency (FEMA) regulations that set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Remedial activities conducted within the 100-year floodplain of the Piscataqua River or federal jurisdictional wetlands would be implemented in compliance with these standards.
STATE				
Other Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 Maine Revised Statutes Annotated (MRSA) 480 et seq.; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream, or brook.	Remedial activities such as excavation near the shoreline or shoreline control maintenance would be conducted so as to avoid washing any soil into the nearby Piscataqua River or adjacent wetlands. Stormwater management and erosion control practices would be used to prevent sediment from entering the river or adjacent wetlands during remedial activities.
Wetlands	Maine Wetland Protection Rules (06-096 CMR Part 310)	Applicable	Standards are provided for protection of wetlands, as defined in MEDEP Ch. 1000 Guidelines for Municipal Shoreline Zoning Ordinances. Jurisdiction under the Rules includes the area adjacent to the wetlands, which is the area within 75 feet of the normal high water line. Activities that have an unreasonable impact on wetlands are prohibited.	Remedial activities such as excavation near the shoreline or shoreline control maintenance would be conducted to avoid impacts to wetlands and coastal wetlands, which include tidal and subtidal lands.

TABLE 2-2: POTENTIAL LOCATION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION / ACTION TO BE TAKEN
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq.*) (06-096 CMR Chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the highwater line of a stream.	Remedial activities such as excavation near the shoreline or shoreline control maintenance that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.

TABLE 2-3: POTENTIAL ACTION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
FEDERAL				
Surface Water	CWA (33 USC §1251 *et seq.*); National Recommended Water Quality Criteria (NRWQC) (40 CFR Part 122.44)	Relevant and Appropriate	These criteria are used to establish water quality standards for the protection of aquatic life.	Remedial activities would be conducted to reduce adverse impacts to the Piscataqua River. Stormwater management and erosion control practices would be used to prevent soil and contamination from entering the river during remedial activities.
Water Management	CWA Section 402 National Pollutant Discharge Elimination System (NPDES) (40 CFR 122.26)	Applicable	CWA Section 402 requires NPDES permits for stormwater discharges to navigable waters.	Stormwater management would be implemented to minimize discharges of contaminants to the Piscataqua River and meet the substantive requirements of this act.

TABLE 2-3: POTENTIAL ACTION-SPECIFIC ARARS AND TBCS

REQUIREMENT	CITATION	STATUS	SYNOPSIS	EVALUATION/ACTION TO BE TAKEN
STATE				
Hazardous Waste	Identification of Hazardous Wastes 06-096 CMR Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing.	Wastes generated during remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste, (38 MRSA 1301 *et seq*., 06-096 CMR Part 851 (5) and (8))	Applicable	These regulations contain requirements for the generators of hazardous waste.	Waste generated during remedial activities that are determined to be hazardous would be managed on site according to the regulation until disposal off site.
Water Management	Maine Discharge Licenses (38 MRSA 413 *et seq*.) and Waste Discharge Permitting Program (06-096 CMR 520-629)	Applicable	These standards regulate the discharge of pollutants from point sources.	These regulations would be applicable to water management during soil excavation and discharges of treat water to a surface water body, if required. The substantive requirements would be met if any discharges of treated water to surface water bodies are required during the remedial action.
Erosion and Sedimentation Control	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to remedial activities that need to address erosion and sedimentation. Applicable plans would be coordinated with MEDEP before implementation.
Storm Water Management	Storm Water Management (38 MRSA Part 420-D; 06-096 CMR Part 500)	Applicable	Storm water management measures must be in place before activities such as filling, displacing, or exposing soil or other earthen material occur on land greater than or equal to 1 acre.	These regulations apply to earth disturbance activities equal to or greater than 1 acre and would be applicable to runoff resulting from earth disturbance activities. Applicable plans would be coordinated with MEDEP before implementation.

TABLE 2-3: POTENTIAL ACTION-SPECIFIC ARARS AND TBCS				
REQUIREMENT	**CITATION**	**STATUS**	**SYNOPSIS**	**EVALUATION/ACTION TO BE TAKEN**
Waste Management	Additional Standards Applicable to Waste Facilities Located in a Flood Plain (06-096 CMR 854.16)	Relevant and Appropriate	Any facility located or to be located within 300 feet of a 100-year flood zone must be constructed, operated, and maintained to prevent wash-out of any hazardous waste by a 100-year flood or have procedures in place that which will cause the waste to be removed to a location where the waste will not be vulnerable to flood waters and to a location which is authorized to manage hazardous waste safely before flood water can reach the facility.	Any remedial activities conducted within 300 feet of the 100-year flood zone would be conducted in compliance with these standards.
Air Emissions	Visible Emissions Regulation (38 MRSA Part 584; 06-096 CMR Part 101).	Applicable	These regulations establish opacity limits for emissions from several categories of air contaminant sources, including general construction activities.	These regulations would be considered for remedial activities that have the potential to impact air quality, such as excavation and backfilling. These standards would be met if any of the activities result in emission of particulate matter and fugitive matter to the atmosphere (e.g., dust generation).

- Prevent industrial worker (construction and occupational) exposure through ingestion of, dust inhalation of, and dermal contact with subsurface soil with dioxins/furans and PCB concentrations exceeding industrial PRGs.

- Protect the offshore environment from erosion of contaminated soil from the OU7 shoreline.

PRGs are chemical-specific goals for representative site concentrations (based on a representative exposure concentration for an exposure unit, not individual sample result concentrations) that, when achieved, the risk posed for receptors will be at an acceptable level. PRGs have been developed on a receptor-specific basis for protection of human health from exposure to soil contaminants. The developed PRGs were used to determine the remediation areas and volumes to be addressed by this FS. The PRGs and associated remediation areas and volumes are discussed in subsequent sections. A discussion of the development of PRGs can be found in Appendix A.

2.4 PRGs FOR OU7

Current, likely future, and hypothetical future site uses and the receptors that may be exposed to contaminated soil at OU7 were considered in the development of PRGs. Exposures for receptors that had potentially unacceptable risks calculated in the RI are summarized as follows. For existing site conditions little or no exposure to surface soil would occur for occupational workers because the majority of OU7 surface soil is covered by parking lots or buildings. People staying at the hotel (Building H23) are not residents and potential exposure is considered occupational. Although residents at PNS are for military use (3 to 4 year tour of duty), residential PRGs for OU7 were developed for hypothetical future residential exposure based on the standard risk assessment residential exposure duration of 30 years for exposure to surface soil and subsurface soil if bought to the surface in the future. Current and future construction worker exposure to soil would only occur if construction activities took place. Occupational worker exposure to subsurface soil is not a current exposure concern and would only occur in the future if subsurface soil were brought to the surface. There are no current plans to change land use at OU7.

Site specific risk-based PRGs were developed for all of the OU7 COCs except lead. ARAR-based PRGs were used for lead. Manganese was identified as a COC for subsurface soil in the OU7 RI Report (Tetra Tech, 2011) because risk calculations showed unacceptable inhalation risks for construction workers exposed to subsurface soil were based on a conservative 150 day per year exposure scenario. For all construction worker PRG calculations, a more realistic construction worker exposure frequency of 60 days per year was used, resulting in a manganese PRG concentration of 1,120 mg/kg, which is greater than the EPC (969 mg/kg); therefore, manganese was removed as a COC in the FS Report. Table 2-4 lists OU7 PRGs for COCs and targeted receptors.

TABLE 2-4: PRG SUMMARY				
Receptor	**Media**	**COC**	**PRG(1) (mg/kg)**	**Basis**
Industrial Worker(2)	Subsurface Soil	Dioxins/Furans(3)	0.0006	Site-specific risk-based non-carcinogen based on HI of 1 (Target organ/system = reproductive and thyroid)
		Total PCBs(4)	7.4	Site-specific risked-based; carcinogen based on ILCR of $1x10^{-5}$
Residential	Surface Soil	Lead	400	OSWER Directive 9355.4-12
	Subsurface Soil	Carcinogenic PAHs(3)	0.5	Site-specific risk-based carcinogen based on ILCR of $3.3x10^{-5}$
		Dioxins/Furans(3)	0.000051	Site-specific risk-based; non-carcinogen based on HI = 1 (Target organ/system = reproductive and thyroid)
		Total PCBs(4)	7.3	Site-specific risked-based; carcinogen based on ILCR of $3.3x10^{-5}$
		Antimony	31	Site-specific risk-based; non-carcinogen based on HI = 1 (Target organ/system = blood)
		Copper	1500	Site specific risk-based; non-carcinogen based on HI = 0.5 (Target organ/system = gastrointestinal system)
		Iron	27,000	Site-specific risk-based; non-carcinogen based on HI = 0.5 (Target organ/system = gastointestinal system)
		Lead	400	OSWER Directive 9355.4-12

(1) PRGs are goals for representative exposure concentrations for an exposure unit and are not intended as pick-up levels. It is possible for a COC to remain on site at concentrations greater than the corresponding EPCs while still being protective of human health and the environment, provided the EPC for that COC is less than the listed PRG.
(2) The industrial worker includes the construction worker and occupational worker.
(3) Dioxins/furans are evaluated based on 2,3,7,8-TCDD TEQs and carcinogenic PAHs are evaluated based on BAP TEQs.
(4) Toxic Substance Control Act (TSCA) PCB Disposal Regulations are not applicable to OU7 because PCB concentrations are less than 50 milligrams per kilogram (mg/kg)

2.5 REMEDIATION AREAS AND VOLUMES

Remediation areas and volumes were estimated by evaluating areas and volumes of that would need to be remediated for the EPCs for COCs to be less than PRGs. Initially, the remediation area and volume was estimated by evaluating the area and volume of contaminated soil that would need to be remediated for unlimited use and unrestricted exposure (i.e., for residential PRGs to be met). For hypothetical future residential exposure to subsurface soil, the majority of the site was identified as the remediation area (i.e., limit of potentially unacceptable risk as shown on Figure 2-1). Based on contaminant distribution, OU7 would likely require remediation at least 5 feet bgs across the entire remediation area for an initial estimate of 38,800 cubic yards. The area is shown on Figure 2-1 and does not include the area in the vicinity of former Building 237, which had concentrations less than PRGs. Elevated concentrations of dioxins/furans and PCBs in subsurface soil within a portion of the former timber basin is the major contributor to potential unacceptable risk for industrial worker exposure. For surface soil risks for hypothetical future residential exposure, elevated concentrations of lead in surface soil within a portion of the former timber basin is the major contributor to potential unacceptable risks. Based on elevated concentrations of lead, dioxins/furans, and PCBs two areas within the former timber basin area were identified for surface and subsurface soil remediation for the indicated receptors. The two areas with elevated COC concentrations are within the limits of potentially unacceptable industrial risk shown on Figure 2-2.

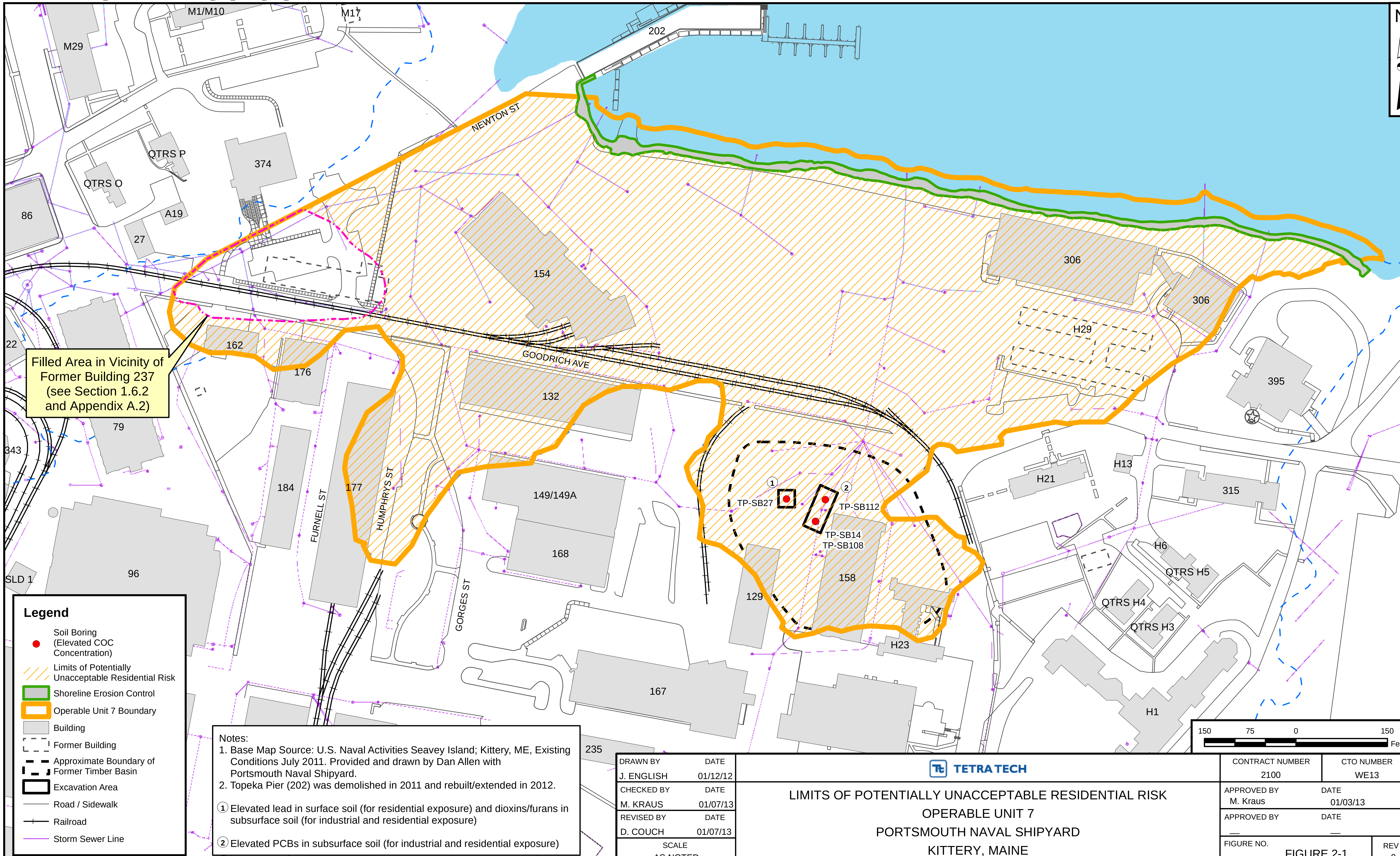
The first area is a 10 by 10 foot area around TP-SB27 with an elevated lead concentration (13,200 mg/kg) that drives potential unacceptable residential risks in surface soil (0 to 2 foot bgs), which is shown on Figures 2-1 and 2-2. Additionally, the greatest OU7 soil concentration of dioxins/furans was detected at TP-SB27 in subsurface soil (2 to 5 feet bgs). The dioxins/furans soil concentration (based on 2,3,7,8-TCDD TEQ) at TP-SB27 of 0.0017 mg/kg is two orders of magnitude greater than the second highest concentration of dioxins/furans detected at OU7 (0.000034 µg/kg at TPSB34 from 2 to 5 feet bgs). Soil from 2 to 5 feet bgs at location TP-SB27 was included as a part of the first elevated concentration area to remove the highest concentration of dioxins/furans detected at OU7 which is collocated with the highest detection of lead in surface soil. The area around TP-SB27 encompasses approximately 100 square feet and the depth of contamination extends to 5 feet bgs. Therefore, the estimated volume of soil with COC concentrations greater than residential PRGs for lead or dioxins/furans at the area around TP-SB27 is approximately 19 cubic yards of soil.

The second area is a 10 by 50 foot area at TP-SB112 and TP-SB108/14 with elevated subsurface PCB concentrations, which is shown on Figures 2-1 and 2-2. The area around sample locations TP-SB112 and TP-SB108/14 contain soil with elevated concentrations of PCBs encompasses 500 square feet and the depth of this contamination extends to 9 feet bgs. Therefore, the estimated volume of soil in the area around sample locations TP-SB112 and TP-SB108/14 is approximately 167 cubic yards.

Removal of exposure (e.g., through excavation or controls on land use) to elevated COCs in the former timber basin would reduce surface soil risks to acceptable levels for residential exposure and reduce subsurface soil risks to acceptable levels for industrial workers (i.e. construction and occupational workers). This determination was made by calculating estimated post-remedial risks based on the assumption that the elevated COC areas were excavated and backfilled with clean soil.

Figures and calculations supporting post-remedial risk estimates are included in Appendix A.2 and estimated areas are provided in Appendix D. The entire shoreline that has shoreline controls was identified as the remediation area for potential future erosion. This area is approximately 42,500 square feet and is shown on Figures 2-1 and 2-2.

PGH P:\GIS\PORTSMOUTH_NSY\MAPDOCS\MXD\SITE32_POT_UNACC_RISK_RESIDENTIAL.MXD 01/07/13 DC



Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.

(1) Elevated lead in surface soil (for residential exposure) and dioxins/furans in subsurface soil (for industrial and residential exposure)

(2) Elevated PCBs in subsurface soil (for industrial and residential exposure)

DRAWN BY	DATE
J. ENGLISH	01/12/12
CHECKED BY	DATE
M. KRAUS	01/07/13
REVISED BY	DATE
D. COUCH	01/07/13
SCALE	
AS NOTED	

TETRA TECH

LIMITS OF POTENTIALLY UNACCEPTABLE RESIDENTIAL RISK
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/03/13
APPROVED BY	DATE
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FIGURE NO.	REV
FIGURE 2-1	0

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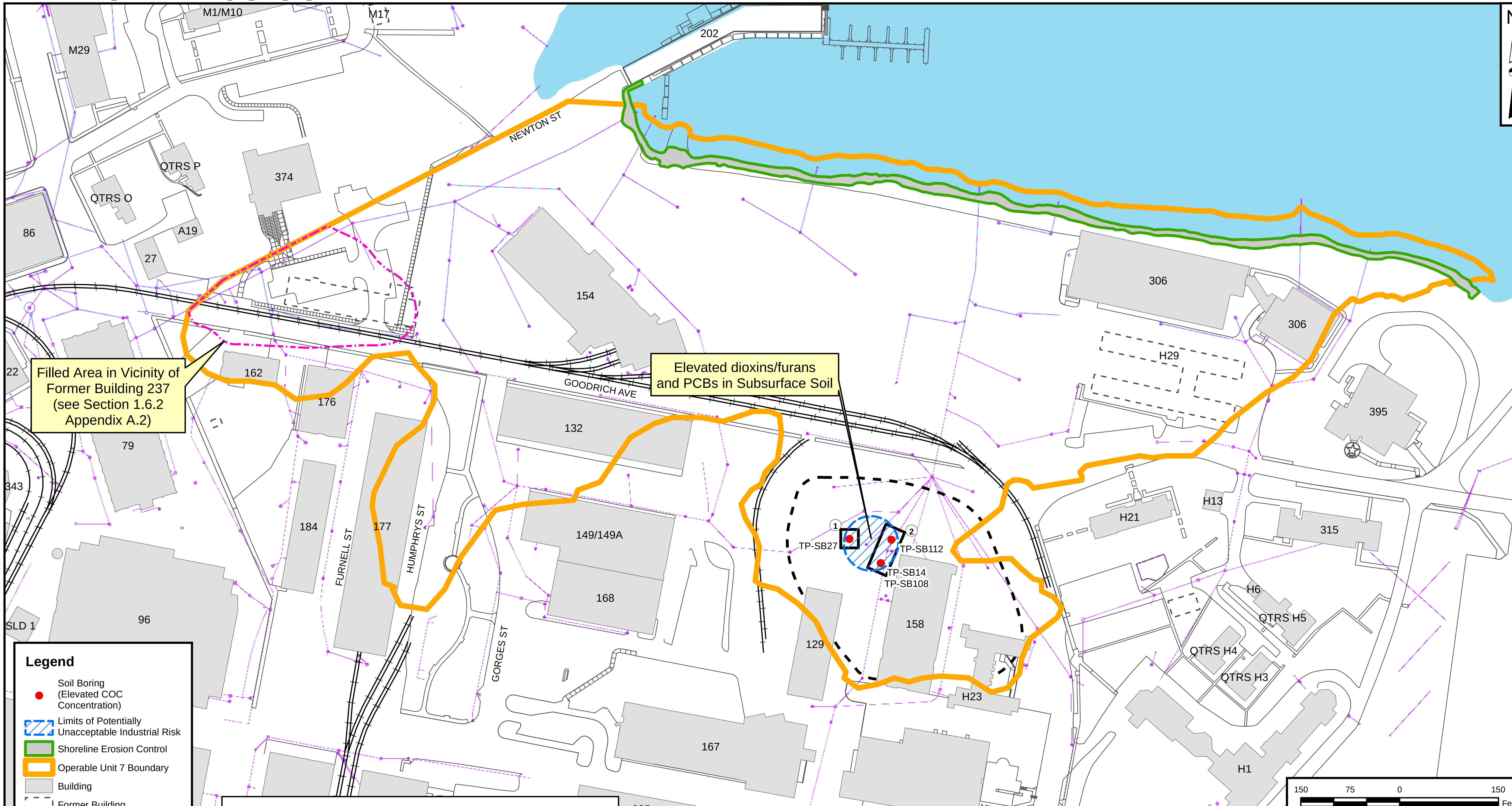

Legend

- Soil Boring (Elevated COC Concentration)
- Limits of Potentially Unacceptable Industrial Risk
- Shoreline Erosion Control
- Operable Unit 7 Boundary
- Building
- Former Building
- Approximate Boundary of Former Timber Basin
- Excavation Area
- Road / Sidewalk
- Railroad
- Storm Sewer Line

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.

(1) Elevated lead in surface soil (for residential exposure) and dioxins/furans in subsurface soil (for industrial and residential exposure)

(2) Elevated PCBs in subsurface soil (for industrial and residential exposure)

DRAWN BY	DATE
J. ENGLISH	05/15/12
CHECKED BY	DATE
M. KRAUS	01/03/13
REVISED BY	DATE
D. COUCH	01/03/13
SCALE	
AS NOTED	

TETRA TECH

LIMITS OF POTENTIALLY UNACCEPTABLE INDUSTRIAL RISK
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/02/13
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE 2-2	0

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND DEVELOPMENT OF ALTERNATIVES

This section identifies and screens potential technologies and process options for the assembly of remedial alternatives for OU7. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options to be used for developing remedial alternatives. Technologies for soil remediation are discussed, and remedial alternatives are assembled in this section. The description of the developed soil remedial alternatives and a detailed analysis of these alternatives are provided in Section 4.0.

Soil remediation technology identification and screening considers the ARARs, COCs, RAOs, PRGs, and areas and volumes of contaminated soil discussed in Section 2.0. This section includes identification of GRAs (Section 3.1), preliminary screening of technologies and process options (Section 3.2), and evaluation of representative remedial technologies (Section 3.3). Alternatives are developed using the retained technologies and process options (Section 3.4). The selection of remediation technologies and process options for initial screening is based on USEPA and Navy guidance (USEPA, 1988 and Navy, 2006). The screening is first conducted at a preliminary level to focus on relevant remediation technologies and process options. Next, the screening is conducted at a more detailed level based on three broad evaluation criteria. Finally, process options are selected to represent the remediation technologies that passed the detailed evaluation and screening.

The evaluation criteria for the detailed screening of soil remediation technologies and process options retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, or volume through treatment; and permanence of solution.
  - Ability of the technology to address the estimated areas and volumes of the contaminated medium.
  - Ability of the technology to meet the RAOs.
  - Technical reliability (innovative versus well proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility of the technology at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.

- Administrative feasibility.
- Special long-term considerations (e.g., maintenance and operation requirements).

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

3.1 GENERAL RESPONSE ACTIONS

GRAs are the broad framework under which remedial technologies are identified to attain RAOs. An assembly of GRAs sets the framework for the development of remedial alternatives for a site. The GRAs for OU7 were assembled with consideration of current and potential future land uses at OU7. The following GRAs were developed for OU7 and are described in the remainder of this subsection:

- No Action
- Limited Action
- Removal
- Treatment
- Disposal

3.1.1 No Action

The no action response is retained throughout the FS process as required by the NCP. The no action response provides a comparative baseline against which other alternatives can be evaluated. Under this response, no remedial action is taken. The contaminated media are left "as is" without the implementation of any monitoring, land use controls (LUCs), containment, removal, treatment, or other mitigating actions.

3.1.2 Limited Action

Limited action includes various LUCs to reduce or eliminate direct contact pathways of exposure. These controls could involve the use of monitoring, land use restrictions, and access controls. The toxicity, mobility, or volume of the contaminants is not reduced through the implementation of LUCs.

3.1.3 Removal

Technologies in this category are used to remove a contaminated medium from its current location for treatment then return it to the site after treatment, or for disposal elsewhere without treatment. Removal actions are combined with other GRAs, such as treatment or disposal actions, to develop remedial alternatives.

3.1.4 Treatment

Technologies in this category include in-situ and ex-situ methods to remove a contaminant from or modify or bind a contaminant in an impacted medium and could include physical, chemical, biological, or thermal treatment techniques. The options typically reduce the overall toxicity, mobility, and volume of the impacted medium. Ex-situ treatment processes are combined with other GRAs, such as removal and disposal actions, to develop alternatives.

3.1.5 Disposal

Disposal actions include placement of removed and/or treated materials within a permanent, approved, and permitted disposal facility. Disposal actions are combined with removal actions and could be combined with treatment actions to develop alternatives. Although the location of the contaminant may change, the toxicity, mobility, and volume of the contaminants are not reduced through the implementation of disposal without a treatment process.

3.2 PRELIMINARY SCREENING OF SOIL TECHNOLOGIES AND PROCESS OPTIONS

A variety of technologies and process options were identified under each GRA and screened to focus on relevant technologies and process options based on the conditions, medium of concern, and COCs at OU7. Technologies and process options retained after the preliminary screenings are provided in Table 3-1 and Table 3-2 summarizes the preliminary screening of technologies and process options.

TABLE 3-1: RETAINED OPTIONS FOR REMEDIAL ALTERNATIVES

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION
No Action	None	Not Applicable
Limited Action	LUCs	Passive Controls: Land Use Restrictions
	Monitoring	Inspection
Removal	Bulk Excavation	Excavation
Disposal	Landfill	Offsite Landfilling

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENT
No Action	None	Not applicable	No activities conducted at the site to address contamination.	**Required by NCP. Retain for baseline comparison to other technologies.**
Limited Action	Land Use Controls	Active Controls: Physical Barriers/ Security Guards	Fencing, markers, warning signs, and monitoring to restrict site access.	Eliminate because contamination is in the subsurface and activity controls are not required to prevent exposure for current site users.
		Passive Controls: Deed or Land Use Restrictions	Administrative action using property deeds or other land use prohibitions to restrict future site activities.	**Retain to prevent future residential development, prevent unauthorized exposure to subsurface soil in portions of the site for current users, and manage excavated soil.**
	Monitoring	Sampling and Analysis	Sampling and analysis of soil, groundwater or other media to evaluate migration of chemical constituents in the environment.	Eliminate because no unacceptable risks associated with migration of contamination are present.
		Inspection	Visual inspection of shoreline.	**Retain to ensure shoreline controls are working properly and that no soil erosion is occurring.**
Containment	Surface Protection	Asphalt Cover	Installation of an asphalt cover to prevent direct exposure to contaminated soil and offsite migration of soil through erosion.	Eliminate because it is not required to prevent current or future exposure based on industrial land use and contaminant migration is not a concern.
		Cap	Installation of a multimedia cap to prevent direct exposure to contaminated soil and prevent infiltration of precipitation to unsaturated zone soil.	Eliminate because it is not required to prevent current of future exposure based on industrial land use and contaminant migration is not a concern.

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS				
GENERAL RESPONSE ACTION	**REMEDIAL TECHNOLOGY**	**PROCESS OPTION**	**DESCRIPTION**	**SCREENING COMMENT**
Containment	Vertical Barrier	Sheet Piling	Installation of a vertical barrier with sheet piling to prevent migration of contaminated soil through the revetment	Eliminate because there are no current risks associated with the migration of contamination through the existing revetment.
	Vapor Protection	Sealing Building Foundations and Installing Vents	Sealing the foundation of buildings and installation of vents outside of the buildings to mitigate vapor intrusion.	Eliminate because VOCs are not COCs for OU7.
Removal	Bulk Excavation	Excavation	Use of construction equipment such as backhoe, front-end loader, grader, etc. to remove contaminated soil.	**Retain. Excavation would effectively remove contaminated soil from the site.**
In-Situ Treatment	Biological	Anaerobic/Aerobic Treatment	Inoculation of microorganisms and nutrients to enhance naturally occurring biodegradation of COCs.	Eliminate because biodegradation is ineffective and not practical for COCs at OU7.
	Physical/ Chemical	Soil Flushing	Use of water or other solvents to remove COCs by flushing and collecting and treating or disposing of the contaminated fluids.	Eliminate because this process would be very difficult to control in-situ because of the very heterogeneous nature of the soil.
		Dynamic Underground Stripping	Injection of steam at the periphery of the contaminated area to volatilize COCs and removal of these COCs through a centrally located extraction well.	Eliminate because of the non- or low-volatility of COCs.
		Soil Vapor Extraction	Use of vacuum and possibly air sparging to volatilize COCs.	Eliminate because PAHs are only partially volatile and PCBs, dioxins/furans, and metals are not.
		Chemical Fixation/ Solidification	Mixing of pozzolanic agents in the vadose zone to chemically fix COCs and solidify the matrix. This technology is primarily used to reduce the mobility of contaminants, but it can also be used to prepare a surface barrier for human uptake.	Eliminate because the use of this technology to reduce the mobility of contaminants or to prepare a surface barrier by in-situ application would be difficult to control due to the heterogeneous nature of the soil

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENT
In-Situ Treatment	Thermal	Vitrification/ Radio Frequency Heating	Use of moderate to high temperature to either volatilize COCs or to fuse them into a glass matrix.	Eliminate because COCs are not particularly volatile and in-situ application of this technology would be difficult to control due to the very heterogeneous nature of the soil.
Ex-Situ Treatment	Physical/ Chemical	Soil Washing/Solvent Extraction	Use of water or other solvents to remove COCs by solubilizing and/or gravity-based separation of contaminated soil particles.	Eliminate because the quantity of excavated material is not large enough for application of this technology cost effectively.
		Chemical Fixation/ Solidification	Mixing of pozzolanic agents to chemically fix COCs and solidify the matrix.	Eliminate because of the uncertainty in its effectiveness for dioxins/furans and PCBs in soil.
	Biological	Onsite Land Farming	Spreading and tilling of contaminated soil into layers of clean surface soil to aerate and biodegrade organic COCs.	Eliminate because it would not be effective for the removal of most COCs except PAHs and because on-yard areas for construction of a treatment bed are very limited.
		Bioslurry Reactor/Biopile	Treatment of soil in a bioslurry reactor or biopile under controlled conditions using natural or cultured microorganisms to biodegrade organic COCs.	Eliminate because it would not be effective for the removal of most COCs except PAHs.
	Thermal	Incineration	Use of high temperatures to destroy COCs.	Eliminate because it would only be effective in destroying portions of the soil containing organic COCs, and it would be ineffective for destroying metals COCs.
		Low-Temperature Thermal Desorption	Use of low to moderate temperatures to evaporate COCs and remove them from soil.	Eliminate because it would not be effective in removing metals COCs.
	Solids Processing	Screening	Removal/segregation of material based on size either as a means to remove associated COCs or as a preliminary process to aid in downstream treatment.	Eliminate because the quantity of excavated material is not large enough for application of this technology cost effectively.

TABLE 3-2: PRELIMINARY SCREENING OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENT
Ex-Situ Treatment	Solids Processing	Crushing/Grinding	Size reduction of wastes as a preliminary process to aid in downstream treatment.	Eliminate because the quantity of excavated material is not large enough for application of this technology cost effectively.
Disposal	Landfill/Recycling	Onsite Landfilling	Disposal of excavated soil and treatment residues in an on-yard landfill.	Eliminate because of lack of space on the yard.
		Offsite Landfilling	Disposal of excavated soil and treatment residues in an offsite permitted treatment, storage, and disposal (TSD) facility.	**Retain to dispose of contaminated soils.**
		Recycling	Recycle of recovered material such as metallic lead pieces.	Eliminate because recoverable materials are not expected in excavated materials.

3.3 DESCRIPTION AND EVALUATION OF SOIL REMEDIATION TECHNOLOGIES AND PROCESS OPTIONS

The technologies and process options retained after preliminary screening are retained based on an evaluation of three broad evaluation criteria. Screening evaluations generally focus on effectiveness and implementability, with less emphasis on cost. Process options that would be precluded by waste or chemical characteristics and inapplicability to site conditions are screened and eliminated from further consideration. At this stage, no process options are eliminated based on cost. However, a process option within a technology category may not be carried through to the alternative development stage if an equally effective process option is available at a lower cost.

3.3.1 No Action

No Action includes no controls, remediation, or other actions to mitigate risks at the site.

Effectiveness

The No Action alternative would not be effective in meeting the RAOs because there would be no action to prevent unacceptable risks from direct human exposure to contaminated soil at OU7.

Implementability

There would be no technical implementability concerns because no actions would be implemented.

Cost

There would be no costs associated with no action.

Conclusion

Although the No Action alternative is not effective in meeting RAOs for OU7, it is retained as required under CERCLA and the NCP. The No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

3.3.2 Limited Action

The limited action GRA retained is use restrictions enforced by institutional controls. Passive institutional controls include deed restrictions and LUCs to limit the potential for exposure to impacted media. The type of institutional controls used would depend on the current and likely future use of the site. The Navy would establish LUCs for a remedy, if needed, in a post-Record of Decision (ROD) LUC Remedial Design (RD). The LUC RD would set out the specific actions needed to implement, operate, maintain, and enforce the LUC component of the remedy.

Effectiveness

LUCs are effective in restricting the type of activities that can be performed in the future at identified areas. However, the effectiveness of LUCs is dependent on the system utilized to communicate the locations and restrictions associated with parcels with LUCs. Currently, there is no reason to anticipate the transfer of OU7 land to the public (i.e., OU7 will be owned by the Navy in the near and extended future). Therefore, deed restrictions are not needed for OU7. Institutional controls would require inspections of land use, identification of planned changes to land use, and inspection of shoreline controls to ensure long-term effectiveness. Long-term maintenance of shoreline controls would be conducted as needed based on the inspections.

Implementability

Institutional controls would be readily implementable for OU7. Resources are readily available for the implementation of institutional controls. Long-term inspection and maintenance of the institutional controls would also be readily implementable.

Cost

Both capital and O&M costs associated with the limited action components are low compared to disposal of contaminated media.

Conclusion

Institutional controls are retained for the development of remedial alternatives. LUCs are required for remedial alternatives (except No Action) where contaminated material remains on site.

3.3.3 Removal

The only technology considered under the removal GRA is bulk excavation, which can be performed by a variety of equipment, such as tractor shovels (front-end loaders), backhoes, and graders. The type of equipment selected must take into consideration several factors, such as the type of material to be removed, load-bearing capacity of the ground surrounding the removal area, depth and areal extent of removal, required rate of removal, and elevation of the groundwater table over the tidal cycle. Excavation is the technology of choice for the removal of well-consolidated material, such as soil to depths of up to

30 feet, and from well-defined areas of ground with significant load-bearing capacity (i.e., greater than 1,500 pounds per square foot).

The logistics of excavation must take into account the available space for operating equipment, loading and unloading to transport the removed material, location of the site, etc. After excavation is completed, the location is generally filled and graded with clean fill material or treated soil.

Effectiveness

Excavation is a well-proven and effective method of removing contaminated soil from a site. Properly designed excavation would remove contaminated soil such that the site meets the RAOs and has no restrictions. Partial excavation designs could remove the bulk of contamination and reduce the severity and amount of restrictions on a site. Excavation could expose workers to contaminants during the implementation phase, although exposure would be minimized through the use of proper health and safety procedures. Excavation could adversely impact the environment, particularly along the shoreline of the site, if appropriate control measures are not implemented. Combined with appropriate treatment and disposal technologies, excavation would provide greater protection of human health than LUCs or surface protection because contaminated material would be removed from the site.

Implementability

Depending on the area and volume of soil, excavation at OU7 would be moderate to very difficult to implement when extending to or below the groundwater table and along the shoreline because it would have to be carefully managed with respect to existing structures, tidal groundwater level fluctuations, high currents in the Piscataqua River, and ongoing operations at and near OU7. Excavation equipment and services are readily available from multiple vendors or contractors. This technology is well proven and established in the construction/remediation industry. During excavation, site-specific health and safety procedures and Occupational Safety and Health Act (OSHA) regulations would have to be complied with to ensure that the exposure of workers to COCs is minimized. This would include the wearing of appropriate personal protective equipment (PPE) and the implementation of dust suppression measures.

Under removal/excavation, consideration is given to excavation in a portion of the former timber basin area, complete excavation, and excavation behind the existing shoreline. Buildings in the surrounding area currently have an occupational use; therefore, dust, debris, and noise produced as a result of excavation would have to be controlled so that occupational workers would not be adversely affected by excavation activities. Excavation would also need to take into account the tidal cycle and the changing groundwater table depth. Appropriate measures would be needed for excavation around above-ground and underground utilities, adjacent to buildings, and along existing shoreline stabilization structures.

Cost

The cost of limited excavation activities at the elevated concentration areas would be moderately greater than typical remedial actions located on native land because the expected excavation areas are located around existing structures and extensive utilities. The cost of complete excavation across OU7 to meet residential PRGs would be extremely high due to the size and location of the site with respect to the Piscataqua River, site use, and extensive utilities. The area of OU7 is approximately 19 acres. As an example, if the entire site were excavated to 5 feet bgs including underneath current buildings, the estimated cost of the excavation and disposal alone without mark-up would be approximately $17 million. The cost of excavation along the entire shoreline revetment would also be high (approximately $3 million) and technically challenging due to its proximity to utility lines and buildings at some sections of the shoreline. For example, Building 306 is close enough to the shoreline that additional measures may need to be taken to ensure structural stability of the building during excavation, which would add to the cost of excavating the shoreline. Primarily due to potential costs but also with consideration of interferences to day-to-day Shipyard operations (e.g. potential utility interferences and parking restrictions), the complete excavation and shoreline excavation alternatives are not further developed in Section 4. Cost estimates for entire site excavation to 5 feet bgs and complete shoreline contamination removal are presented in Appendix C.1.

Conclusion

Excavation in a portion of the former timber basin is retained in combination with other processes (e.g., offsite disposal) for the development of remedial alternatives. Complete excavation (complete removal of all contaminants across OU7) and excavation of the shoreline are not considered for alternative development due to implementation difficulties and high costs.

3.3.4 Disposal

The only technology considered under this GRA is offsite landfilling. Offsite landfilling consists of transporting excavated soil for disposal in a permitted offsite TSD facility. RCRA non-hazardous waste may be disposed in an RCRA Subtitle D, or solid waste, landfill. RCRA hazardous waste must be disposed in an RCRA Subtitle C, or hazardous waste, landfill. Soil would be characterized for proper disposal. It is anticipated that the material excavated from OU7 would include both RCRA non-hazardous and RCRA hazardous materials.

Effectiveness

Offsite landfilling does not permanently or irreversibly reduce contaminant concentrations. Although the CERCLA preference for treatment relegates direct landfilling to a less preferable option, offsite landfilling would be an effective disposal option for contaminated soil at OU7. Offsite landfills are only permitted to operate if they meet certain requirements of design and operation governing foundation, liner, leak detection, leachate collection and treatment, daily cover, post-closure inspections, and monitoring, etc., which ensure the effectiveness of these facilities. The requirements of a RCRA Subtitle C hazardous waste landfill are significantly more stringent than those of a RCRA Subtitle D solid waste landfill.

Implementability

Offsite landfilling without treatment would be easily implementable. Permitted RCRA Subtitle C TSD facilities and Subtitle D landfill facilities are available for this purpose. The bulk of soil at OU7 has moderate to low concentrations of COCs and would be characterized as a RCRA non-hazardous waste. Soil in the elevated areas in the former timber basin may be characterized as RCRA hazardous waste. Based on the low volume of hazardous waste anticipated, it is assumed that any treatment for disposal would be conducted at the TSD facility.

Cost

The cost of offsite landfilling would be low to moderate for disposal at a RCRA Subtitle D solid waste landfill and high for treatment/disposal at a RCRA Subtitle C hazardous waste landfill.

Conclusion

Offsite landfilling is retained in combination with other process options for the development of remedial alternatives.

3.4 DEVELOPMENT OF SOIL REMEDIATION ALTERNATIVES

The following technologies/process options were retained to develop soil remedial alternatives:

- No Action
- Institutional Controls
- Excavation and Offsite Landfilling

The retained technologies/process options were used to develop three soil remedial alternatives for OU7. Detailed descriptions and evaluations of the alternatives are provided in Section 4.0. The alternatives being considered are discussed below.

- Alternative 1 – No Action
- Alternative 2 – LUCs and Long-term Management (LTMgt) of Shoreline Controls
- Alternative 3 – Limited Excavation in Former Timber Basin Area, Residential LUCs, and LTMgt of Shoreline Controls

4.0 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents descriptions of the remedial alternatives developed for OU7 and evaluations of each remedial alternative with respect to the criteria of the NCP of 40 CFR 300, as revised in 1990. The criteria and relative importance of these criteria in the CERCLA process are discussed in Section 4.1, and the description and detailed analyses of alternatives are provided in Section 4.2.

4.1 NCP EVALUATION CRITERIA AND RELATIVE IMPORTANCE OF CRITERIA

The evaluation criteria as required by the NCP and the relative importance of these criteria in the CERCLA process are described in the following subsections.

4.1.1 Evaluation Criteria

In accordance with the NCP (40 CFR 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

Overall Protection of Human Health and the Environment

Remedial alternatives must be assessed for adequate protection of human health and the environment in both the short and long term. The remedial alternatives must be able to diminish the unacceptable risks posed by hazardous substances or contaminants present at the site by eliminating, reducing, or controlling exposure to levels exceeding remediation goals.

Compliance with ARARs

Remedial alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. If one or more regulations that are applicable cannot be complied with, a waiver must be invoked.

Long-Term Effectiveness and Permanence

Remedial alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative would prove successful. Factors that are considered as appropriate include the following:

- Magnitude of Residual Risk - Risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and reliability of controls - Controls, such as containment systems and LUCs, necessary to manage treatment residuals and untreated waste must be shown to be reliable. In particular, this evaluation considers the uncertainties associated with land disposal for providing long-term protection from residual contamination, assessment of the potential need to replace technical components of the alternative (such as a surface cover or treatment system), and the potential exposure pathways and risks posed if technical components or the entire remedial action needs to be replaced.

Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the remedial alternative employs recycling or treatment that reduces the toxicity, mobility, or volume is assessed. This assessment includes how treatment is used to address threats posed by the site. Factors to be considered as appropriate include the following:

- Treatment or recycling processes that the remedial alternative employs and the materials that they will treat.

- Amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- Degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the specification of which reduction(s) is occurring.

- Degree to which the treatment is irreversible.

- Type and quantity of residual contamination that will remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- Degree to which treatment reduces the inherent hazards posed by principal threats at the site.

Short-Term Effectiveness

The short-term impacts of the remedial alternative are assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures taken to minimize these impacts.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

Implementability

The ease or difficulty of implementing the alternative is assessed considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the time required obtaining approvals and permits (if needed) from other agencies.

- Availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; availability of necessary equipment, specialists, and additional resources; availability of services and materials; and availability of prospective technologies.

Cost

Costs for remedial alternatives include both capital costs and annual O&M costs. Capital costs include both direct and indirect costs expected at the time of alternative implementation. Annual O&M costs include periodic costs that occur following alternative implementation. Typical O&M costs include periodic long-term monitoring and inspections. A net present worth (NPW) of the capital and O&M costs is also provided. The NPW of a remedial alternative is the total of all capital and O&M costs expressed in today's dollars. Typically, the cost estimate accuracy range during the FS stage is plus 50 percent to minus 30 percent of the actual remedial action cost.

State Acceptance

This criterion reflects the statutory requirements to provide for substantial and meaningful regulatory involvement. Formal assessment of regulatory acceptance is completed during the ROD phase, occurring after the PRAP public comment period. However, regulatory concerns are continually considered through resolution of regulatory comments received on the FS Report and PRAP.

Community Acceptance

This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are considered throughout the CERCLA process. The community acceptance criterion is evaluated as part of the responsiveness summary presented in the ROD after the public comment period on the PRAP is held. However, community input is obtained through presentation of draft documents including the draft FS and PRAP reports at Restoration Advisory Board (RAB) meetings.

4.1.2 <u>Relative Importance of Criteria</u>

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of alternatives.

The remaining two criteria, State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. These last two criteria are evaluated after the end of the public comment period on the PRAP. Therefore, this FS addresses seven of the nine criteria.

4.2 DESCRIPTION AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

As noted in Section 3.4, the following remedial alternatives have been developed for soil at OU7:

- Alternative 1 – No Action
- Alternative 2 – LUCs and LTMgt of Shoreline Controls
- Alternative 3 – Limited Excavation in Former Timber Basin Area, Residential LUCs, and LTMgt of Shoreline Controls

A description and detailed analysis of these alternatives are provided in the following sections.

4.2.1 <u>Alternative 1: No Action</u>

4.2.1.1 Description

This alternative is required under CERCLA to establish a basis for comparison with other alternatives. No Action includes no controls, remediation, or other actions to mitigate risks. Five-year reviews are also not included under the No Action alternative.

4.2.1.2 Detailed Analysis

<u>Overall Protection of Human Health and the Environment</u>

Alternative 1 would not be protective of human health and the environment, and would not meet the RAOs for OU7 because no action would be conducted to ensure that exposure to or erosion of site contamination does not occur in the long term.

Compliance with ARARs

Alternative-specific ARARs for Alternative 1 are provided in Table B-1 in Appendix B. As shown in Table B-1, there are no chemical-specific, location-specific, or action-specific ARARs for this alternative. Chemical-specific TBCs would not be met.

Long-Term Effectiveness and Permanence

Alternative 1 would not provide long-term effectiveness and permanence. No action would provide no reduction of risks or reliable controls to protect against unacceptable exposure to contamination in the long term or erosion.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 would not reduce toxicity, mobility, or volume through treatment. There are no principal treatments or processes associated with this No Action alternative. Reduction of contaminant toxicity, mobility, and volume may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

No action would occur; therefore, implementation of Alternative 1 would not pose a short-term risk to onsite workers or result in adverse impacts to the local community or the environment. Alternative 1 would not provide adequate protection and would not meet RAOs because no action would be conducted.

Implementability

Alternative 1 would be readily implementable because there would be nothing to implement. The technical feasibility criteria including constructability, operability, and reliability are not applicable. The implementability of administrative measures is not applicable because no such measures would be taken.

Cost

There would be no costs associated with Alternative 1 because there are no remedial components.

4.2.2 Alternative 2: LUCs and LTMgt of Shoreline Controls

4.2.2.1 Description

Alternative 2 consists of instituting LUCs to prevent unacceptable exposure to contaminated surface and subsurface soil and to maintain shoreline stabilization features to prevent erosion (Figure 4-1). The following describes the individual components of Alternative 2:

- LUCs and Inspections – The intent of LUCs is to ensure that the land use and shoreline stabilization controls remain in place so that contact with contaminants at concentrations that would cause potentially unacceptable risk are prevented for the life of the remedy. LUCs would prevent residential land use within the residential LUC boundary and prevent unrestricted exposure to subsurface soil within the industrial LUC boundary (see Figure 4-1). LUCs would require the continued presence of the shoreline stabilization controls along the entire length of the northern boundary to prevent erosion of contaminated soil and debris to the near offshore area. To implement LUCs, the Navy would prepare a LUC RD that would document the LUCs, inspection requirements, and organizations responsible for implementation of LUCs. Requirements for management of excavated soil as part of any future construction activities at the site would also be included as part of the LUCs. Specifics for shoreline stabilization inspection and maintenance activities would be described in an LTMgt plan for OU7. Most of the site is covered by pavement or buildings and contamination for current industrial use is not in surface soil; therefore, fencing for perimeter controls, asphalt or ground cover, or other active measures are not necessary to prevent exposure to site contamination. For the purposes of the FS and developing a cost estimate, it was assumed that annual inspections of the site would be conducted to verify continued effectiveness of the LUCs. For the shoreline controls, it was assumed that maintenance would be required every 15 years and it would include replacement of a portion of the shoreline controls.

- Five-Year Reviews – Because contamination would remain in excess of levels that allow for unlimited use and unrestricted exposure, five-year reviews would be required under this alternative to evaluate the continued adequacy of the remedy.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment. Implementation of LUCs under Alternative 2 would provide a formal process to inspect and maintain the controls for the site to ensure the effectiveness of LUCs in preventing unacceptable exposure for industrial workers within the industrial LUC boundary and future residential users within the residential LUC boundary and to prevent future erosion of the shoreline. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Compliance with ARARs

Alternative-specific ARARs for Alternative 2 are provided in Table B-2 in Appendix B. The implementation of Alternative 2 would comply with all ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 2 would provide long-term effectiveness and permanence. Although soil COC concentrations would not be actively reduced, risks to human health and the environment would be minimized through implementation of LUCs and maintenance of shoreline stabilization controls. Under Alternative 2, the site would be suitable for continued industrial use, and LUCs would restrict future residential use within the residential LUC boundary. LUCs would provide a process to inspect and maintain site restrictions to prevent unacceptable exposure of current site users to contamination in subsurface soil within the industrial LUC boundary, proper management of soil if excavated in the future, and a process to inspect and maintain shoreline controls to prevent future erosion via a LTMgt plan. Adequate protection for remediation workers, construction best management practices, and other controls would be provided to prevent impacts to human health and the environment as part of long-term maintenance of the shoreline stabilization controls. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 does not provide any active treatment technologies that would reduce toxicity, mobility, or volume of the contaminants in surface or subsurface soil. Reduction of contaminant toxicity, mobility, and volume may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

Alternative 2 would be effective in the short term. Implementation of LUCs would not pose short-term risk to site workers or result in adverse impacts to the surrounding community or the environment.

Alternative 2 has an overall low to moderate environmental impact as determined in Appendix E. The environmental impact due to greenhouse gases (GHG) emissions, nitrous and sulfur oxides emission, particulate matter emissions, and energy consumption are estimated to be low to moderate and the activity responsible for the majority of these impacts is the use of an excavator assumed to be needed as part of potential long-term maintenance activities for the shoreline controls.. The impact on water consumption is considered low given that there is no direct use of water resulting from the activities taking place under Alternative 2.

Alternative 2 could be implemented within 12 months with the preparation of the LUC RD and LTMgt plan preparation, which would include directions for inspection and maintenance. RAOs would be attained after the LUC RD is implemented.

Implementability

Alternative 2 would be readily implementable. Administratively, implementation and enforcement of LUCs, LTMgt, and five-year reviews would be relatively simple to implement.

Cost

Cost estimates for Alternative 2 are included in Appendix C.2. The estimated costs (rounded to $1,000) for Alternative 2 are as follows:

- Capital cost: $15,000
- Annual costs: $3,000/year, plus $25,000 every 5 years, plus $142,000 every 15 years
- 30-year NPW: $381,000

4.2.3 Alternative 3: Limited Excavation in Former Timber Basin Area, Residential LUCs, and LTMgt of Shoreline Controls

4.2.3.1 Description

Alternative 3 consists of excavation and offsite disposal of PCB, lead, and dioxin/furan contaminated soil in the former timber basin, LUCs to prevent residential exposure to subsurface soil, and LTMgt to maintain shoreline stabilization features to prevent erosion. Figure 4-2 shows the proposed excavation and LUCs boundaries. The following describes the individual components of Alternative 3:

- Excavation and Offsite Disposal – Areas with lead, PCB, and dioxin/furan contamination within the former timber basin (encompassing TP-SB27, TP-SB112, and TP-SB14/108) would be excavated to the maximum depth (above the groundwater table at high tide) where exceedances of PRGs were found. Figures 4-3 and 4-4 show the location of a cross-section and a cross-section figure of the areas that would be excavated. The excavation would reduce surface soil risks to acceptable levels for residential exposure and reduce subsurface soil risks to acceptable levels for industrial worker exposure. Confirmation samples would be collected from the floor and sidewalls of each excavation area to confirm that soil with lead concentrations driving potentially unacceptable future hypothetical surface soil risks, and dioxin/furan and PCB concentrations in subsurface soil driving potentially unacceptable industrial worker risks have been removed. The actual limits and depths of excavation would be determined by the results of the confirmation samples. All excavated material would be stockpiled, characterized, and properly transported and disposed at an appropriate TSD facility. For the purposes of the FS and developing a cost estimate, it was assumed that shoring would be needed to protect workers and the building foundation within or adjacent to the excavation area. It was also assumed that utilities within the excavation area would need to be removed and replaced or bypassed.

- Site Restoration – Following excavation, the excavated areas would be backfilled to establish pre-construction grades, elevations, and surface types using clean soil and pavement where necessary.

- LUCs and Inspection – LUCs would prevent residential land use within the residential LUCs boundary (see Figure 4-2). LUCs would require the continued presence of the shoreline stabilization controls along the entire length of the northern boundary to prevent erosion of contaminated soil and debris to the near offshore area. To implement LUCs, the Navy would prepare a LUC RD that would document the LUCs, inspection requirements, and organizations responsible for implementation of LUCs. Requirements for management of excavated soil as part of any future construction activities at the site would also be included as part of the LUCs. Shoreline stabilization inspection and maintenance requirements would be described in an LTMgt plan for OU7. For the purposes of the FS and developing a cost estimate, it was assumed that annual inspections of the site would be conducted to verify continued effectiveness of the LUCs. For the shoreline controls, it was assumed that maintenance would be required every 15 years and it would include replacement of a portion of the shoreline controls.

- Five-Year Reviews – Because contamination would still remain in excess of levels that allow for unlimited use and unrestricted exposure, five-year reviews would be required under this alternative to evaluate the continued adequacy of the remedy.

4.2.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment. Excavation in the former timber basin and offsite disposal of contaminated soil would reduce site risks for exposure to surface soil to an acceptable level for residential use and site risks for exposure to subsurface to acceptable levels for industrial use. Proper controls during excavation and appropriate transportation and disposal of excavated soil and backfilling would minimize the adverse impact from contaminated soil to human health and the environment during construction. After implementation, LUCs would provide a formal process to inspect and maintain the controls for the site to ensure the effectiveness of LUCs in preventing unacceptable exposure for future residential users within the residential LUC boundary and to prevent erosion of the shoreline. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Compliance with ARARs

Alternative-specific ARARs for Alternative 3 are provided in Table B-3 in Appendix B. The implementation of Alternative 3 would comply with all ARARs for this alternative.

Long-Term Effectiveness and Permanence

Alternative 3 would provide long-term effectiveness and permanence. Excavation of the contaminated area within the former timber basin would reduce COC concentrations to acceptable levels in surface for residential exposure and in subsurface soil for industrial workers. LUCs would provide a process to inspect and maintain residential site restrictions, proper management of subsurface soil if excavated in the future, and inspection and maintenance of the shoreline to prevent potential future erosion via a LTMgt plan. Following implementation of Alternative 3, the site would be suitable for continued use, and LUCs would restrict future residential receptors from coming into contact with contamination in subsurface soil. Adequate protection for remediation workers, construction best management practices, and other controls would be provided to prevent impacts to human health and the environment as part of long-term maintenance of the shoreline stabilization controls. Five-year reviews would be conducted to evaluate the continued adequacy of the remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 does not provide any active treatment technologies that would reduce toxicity, mobility, or volume of contaminants in surface or subsurface soil. Reduction of contaminant toxicity, mobility, and volume may occur over the long term through natural processes, but with the contaminants on site, this would be expected to be a lengthy process.

Short-Term Effectiveness

Alternative 3 would be effective in the short term. Controls would be implemented during excavation, offsite transportation and disposal, backfilling, and regrading activities to protect remediation construction workers, site users, Shipyard employees, and the environment until the construction is completed. These controls would include providing adequate PPE for remediation construction workers, designated access trails for the employees of buildings around the excavation area, and construction best management practices to prevent the spread of contamination during construction. In addition, because the excavation would be occurring within an active portion of the Shipyard, implementation of engineering controls, such as dust suppression and erosion controls, and appropriate location and timing of activities would be needed to ensure that the activities would not adversely impact the Shipyard daily operation or the environment. Upon construction completion, the restored excavation area and implementation of LUCs would not adversely impact the Shipyard or the environment.

The remedial action documents (design and/or work plan) would specify the necessary activities to ensure protection of human health and the environment during remedial activities. The work plan would specify the necessary health and safety requirements for remedial activities, including appropriate PPE to minimize exposure to onsite workers and dust suppression requirements during excavation.

Alternative 3 has an overall high environmental impact as detailed in Appendix E. The impact in GHG emissions and nitrous and sulfur oxide emissions are considered high and the highest contribution to this impact is the use of the excavator for soil excavation and for potential long-term maintenance activities for the shoreline controls. The impact of Alternative 3 on particulate matter emissions is also considered high with the highest contribution to these emissions being the production of asphalt. The impact that Alternative 3 has on the energy consumption is considered high and the production of borrow soil is the highest consumer of energy. The total amount of water consumed through Alternative 3 is estimated as 1,260 gallons of water, where decontamination water as part of soil excavation is the activity with the highest consumption of water, making the impact on water use to be high.

Alternative 3 could be implemented within 12 months. Remedial action documents, LUC RD, and LTMgt plan preparation could be completed within 12 months. Construction activities (excavation, offsite transportation and disposal, grading, backfilling, and repaving) would be expected to take two months. Unexpected delays and slower production times may result due to the presence of utilities and industrial activity in the area. RAOs would be attained after excavation of contaminated soil is complete and the LUC RD is implemented.

Implementability

Alternative 3 would be implementable. The resources, equipment, and materials required for the excavation, backfilling and grading are readily available. Permitted landfill facilities are also available for soil disposal. This is an active area of the Shipyard with various utilities in this area. Therefore, utilities would need to be located and protected during the implementation of this alternative.

The remedial action documents would provide the specifications for excavation, characterization, transportation and disposal of contaminated soil, and backfilling of clean soil in the excavation area. The necessary health and safety requirements for any construction activities conducted as part of implementation of the remedy would be identified in the work plan.

Offsite transportation of the excavated soil could cause significant truck traffic through the Shipyard and would require preparation and implementation of a traffic control plan and the completion of waste manifests. Offsite disposal of the excavated soil would require prior securing of waste acceptance from the disposal facility. Significant coordination with the Shipyard during remedial activities would be required to ensure that the activities do not adversely impact Shipyard operations. These administrative procedures could be accomplished.

Administratively, implementation, and enforcement of LUCs, LTMgt, and five-year reviews would be relatively simple to implement.

Cost

Cost estimates for Alternative 3 are included in Appendix C. The estimated costs (rounded to $1,000) for Alternative 3 are as follows:

- Capital cost: $760,000
- Annual costs: $3,000/year, plus $25,000 every 5 years, plus $142,000 every 15 years
- 30-Year NPW: $1,127,000

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Legend

- Soil Boring (Elevated COC Concentration)
- Shoreline Erosion Control
- Industrial LUCs Boundary (for subsurface soil)
- Residential LUCs Boundary
- Building
- Former Building
- Approximate Boundary of Former Timber Basin
- Excavation Area
- Road / Sidewalk
- Railroad
- Storm Sewer Line

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuild/extended in 2012.

(1) Elevated lead in surface soil (for residential exposure) and dioxins/furans in subsurface soil (for industrial and residential exposure)

(2) Elevated PCBs in subsurface soil (for industrial and residential exposure)

DRAWN BY	DATE
J. ENGLISH	01/12/12
CHECKED BY	DATE
M. KRAUS	02/22/13
REVISED BY	DATE
D. COUCH	02/22/13
SCALE AS NOTED	

TETRA TECH

ALTERNATIVE 2 INDUSTRIAL AND RESIDENTIAL LUCs BOUNDARIES
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY M. Kraus	DATE 01/02/13
APPROVED BY __	DATE __
FIGURE NO. FIGURE 4-1	REV 0

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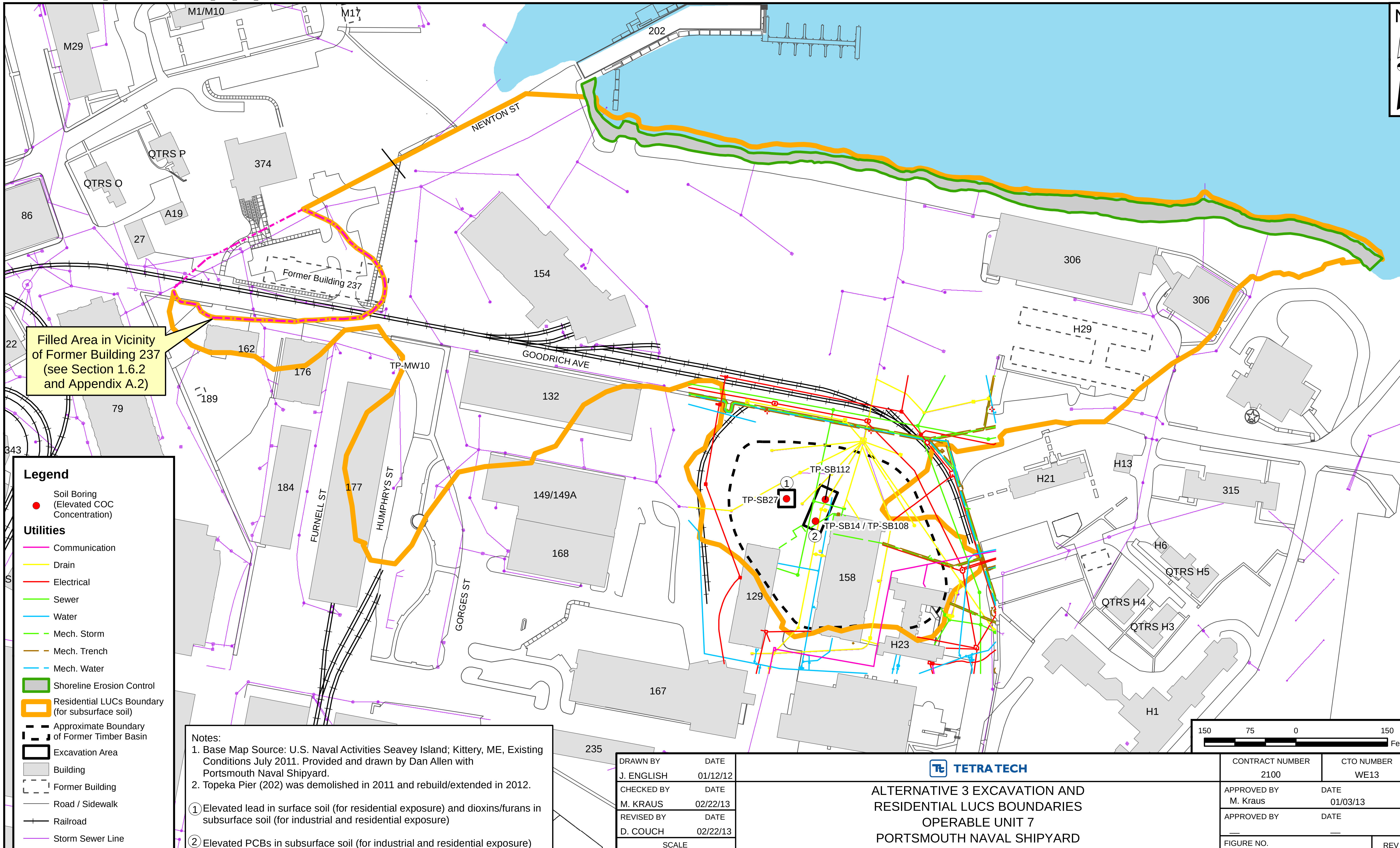

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuild/extended in 2012.

(1) Elevated lead in surface soil (for residential exposure) and dioxins/furans in subsurface soil (for industrial and residential exposure)

(2) Elevated PCBs in subsurface soil (for industrial and residential exposure)

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J. ENGLISH	01/12/12
CHECKED BY	DATE
M. KRAUS	02/22/13
REVISED BY	DATE
D. COUCH	02/22/13
SCALE	
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TETRA TECH

ALTERNATIVE 3 EXCAVATION AND
RESIDENTIAL LUCS BOUNDARIES
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/03/13
APPROVED BY	DATE
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FIGURE NO.	REV
FIGURE 4-2	0

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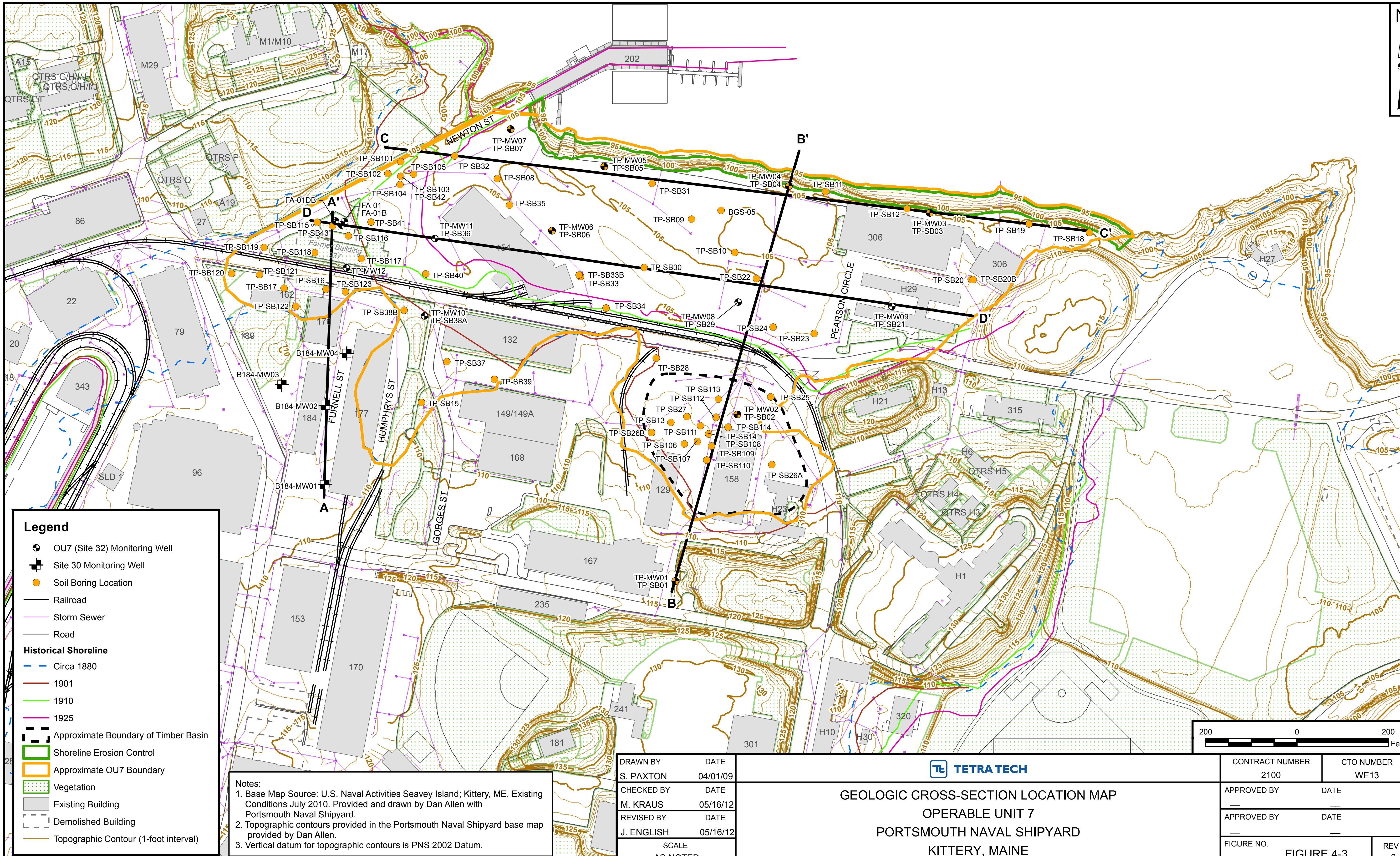


Legend

- OU7 (Site 32) Monitoring Well
- Site 30 Monitoring Well
- Soil Boring Location
- Railroad
- Storm Sewer
- Road

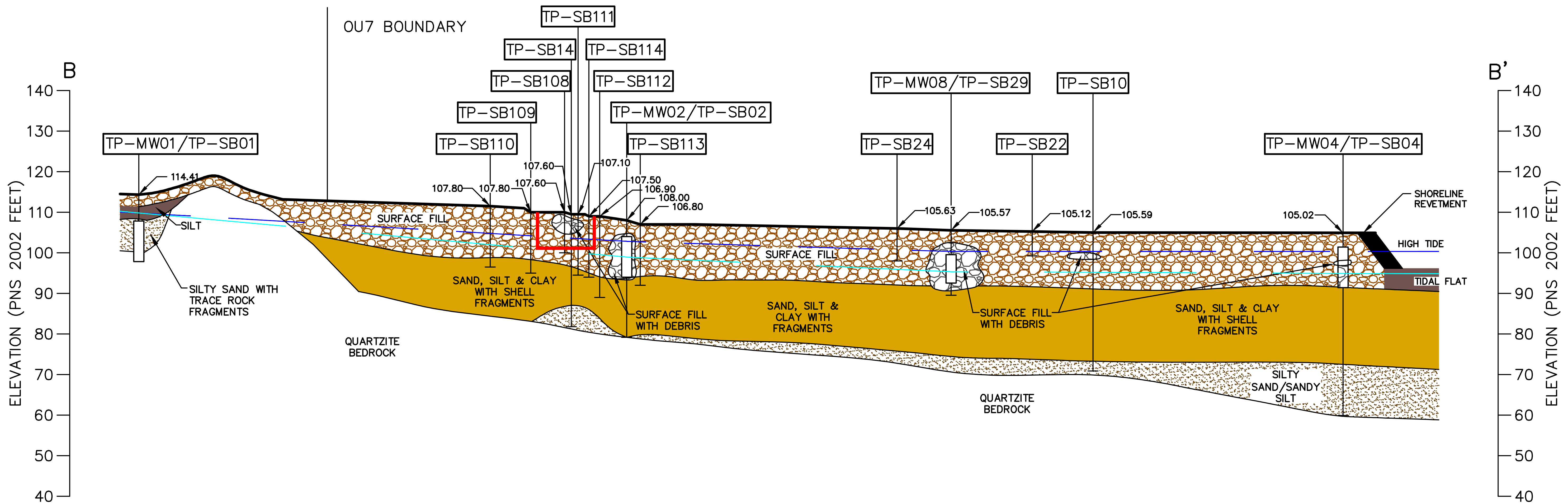
Historical Shoreline

- Circa 1880
- 1901
- 1910
- 1925
- Approximate Boundary of Timber Basin
- Shoreline Erosion Control
- Approximate OU7 Boundary
- Vegetation
- Existing Building
- Demolished Building
- Topographic Contour (1-foot interval)

Notes:

1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2010. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topographic contours provided in the Portsmouth Naval Shipyard base map provided by Dan Allen.
3. Vertical datum for topographic contours is PNS 2002 Datum.

DRAWN BY	DATE		CONTRACT NUMBER	CTO NUMBER
S. PAXTON	04/01/09	TETRA TECH	2100	WE13
CHECKED BY	DATE	GEOLOGIC CROSS-SECTION LOCATION MAP	APPROVED BY	DATE
M. KRAUS	05/16/12	OPERABLE UNIT 7	—	—
REVISED BY	DATE	PORTSMOUTH NAVAL SHIPYARD	APPROVED BY	DATE
J. ENGLISH	05/16/12	KITTERY, MAINE	—	—
SCALE			FIGURE NO.	REV
AS NOTED			FIGURE 4-3	0



LEGEND:

SURFACE FILL
SILT, SAND, AND GRAVEL OR ROCK FRAGMENTS (GENERALLY GREENISH-GRAY QUARTZITE)

SURFACE FILL WITH DEBRIS
SURFACE FILL WITH MINOR DEBRIS SUCH AS SLAG, ASH, METAL, CINDERS, COAL CLINKERS, WOOD, PLASTIC, GLASS, CONCRETE, PORCELAIN, OR BRICK.

SILT OR SILT AND CLAY
NATIVE SILT OR SILT AND CLAY, LANDWARD OF FORMER SHORELINE.

NATIVE SILT, SAND, AND CLAY
NATIVE SAND, SILT, AND/OR CLAY, TYPICALLY WITH SHELL FRAGMENTS.

SILTY SAND
NATIVE SILTY SAND OR SILT AND SAND. TRACE GRAVEL POSSIBLE.

BEDROCK
DARK GRAY OR GREENISH-GRAY METAMORPHIC QUARTZITE.

EXCAVATION AREAS

NOTE:

1. GROUND SURFACE ELEVATIONS ESTIMATED FOR BORINGS TP-SB108 THROUGH TP-SB114.
2. CROSS SECTION FROM OU7 RI, (TETRA TECH, 2012) WITH EXCAVATION AREA SHOWN IN RED.
3. FIGURE ONLY SHOWS EXCAVATION AREAS THAT FALL ON CROSS SECTION B-B'. ANOTHER EXCAVATION AREA EXISTS FOR LOCATION TP-SB27 TO A DEPTH OF 5 FEET BELOW GROUND SURFACE.

0 75 150
HORIZONTAL SCALE IN FEET

0 25 50
VERTICAL SCALE IN FEET

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PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

GEOLOGICAL CROSS SECTION B-B'
OPERABLE UNIT 7

DATE:	01/02/13
PROJECT NO.:	112G02100
DESIGNED BY:	
DRAWN BY:	MF
CHECKED BY:	MK
SHEET:	1 OF 1
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5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the remedial alternatives presented in Section 4.0 of this FS using the criteria used for the detailed analysis of individual alternatives.

TABLE 5-1: COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

EVALUATION CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LUCS AND LTMGT OF SHORELINE CONTROLS	ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LUCS, AND LTMGT OF SHORELINE CONTROLS
Overall Protection of Human Health and Environment	Would not be protective of human health and the environment and would not meet the RAOs because no action would occur to ensure that exposure to site contamination or shoreline erosion would not occur in the future.	Would be protective of human health and the environment by implementing LUCs to prevent exposure to site contamination and shoreline erosion.	Would protect human health and the environment by removing the contaminated soil in the former timber basin to reduce concentrations to acceptable levels in surface soil for residential exposure and to acceptable risk levels in subsurface soil for industrial exposure. LUCs would be implemented to prevent residential exposure to subsurface soil contamination and shoreline erosion.
Compliance with ARARs	There are no ARARs. Chemical-specific TBCs would not be met.	Would comply with ARARs.	Would comply with ARARs.
Long-Term Effectiveness and Permanence	Would not provide long-term effectiveness and permanence because no action would occur.	Would provide long-term effectiveness and permanence so long as the LUCs are active and maintained. Periodic inspections would be conducted to ensure LUCs and shoreline stabilization controls are being maintained. Any maintenance activities for the shoreline stabilization controls would be conducted in accordance with a LTMgt plan.	Would provide long-term effectiveness and permanence by removing contaminated soil in the former timber basin to reduce concentrations to acceptable levels in surface soil (residential) and in subsurface soil (industrial) receptors. Periodic inspections would be conducted to ensure LUCs and shoreline stabilization controls are being maintained. Any maintenance activities for the shoreline stabilization controls would be conducted in accordance with a LTMgt plan.

TABLE 5-1: COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

EVALUATION CRITERION	ALTERNATIVE 1: NO ACTION	ALTERNATIVE 2: LUCS AND LTMGT OF SHORELINE CONTROLS	ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LUCS, AND LTMGT OF SHORELINE CONTROLS
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility, or volume through treatment because no treatment would occur.
Short-Term Effectiveness	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no construction actions would occur. RAOs would not be attained.	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no construction actions would occur. Could be implemented within 12 months and would attain RAOs upon implementation.	Would require appropriate use of PPE and best management practices to prevent exposing site workers, the surrounding community, and the environment to contaminated materials during excavation and offsite disposal activities. Could be implemented within 12 months and would attain RAOs within two months of implementation.
Implementability	Technical and administrative implementation would be simple because there would be no action to implement.	Readily implementable. There would be no technical implementation under this alternative. The administrative implementation is expected to be a simple process. Implementation would require the development of a LUC RD and LTMgt plan.	Moderately implementable. Technical implementation of this alternative would include the excavation and offsite transportation and disposal of contaminated soils, and backfilling and regrading the excavated areas. The main implementability concern for excavation is for excavating around utilities and near building foundations. The administrative implementation is expected to be a simple process. Administrative implementation would require the development of a LUC RD and LTMgt plan.

TABLE 5-1: COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES			
EVALUATION CRITERION	**ALTERNATIVE 1: NO ACTION**	**ALTERNATIVE 2: LUCS AND LTMGT OF SHORELINE CONTROLS**	**ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LUCS, AND LTMGT OF SHORELINE CONTROLS**
Costs (rounded to $1,000): Capital	$0	$15,000	$760,000
Annual	$0	$3,000/year, plus $25,000/5 years, plus $142,000/15years	$3,000/year, plus $25,000/5 years, plus $142,000/15 years
NPW	$0	$381,000	$1,127,000

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APPENDIX A

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS AND ADDITIONAL RISK EVALUATIONS

APPENDIX A.1

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

APPENDIX A.1

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

The methodology used to develop preliminary remediation goals (PRGs) for chemicals of concern (COCs) for Operable Unit 7 is described herein. Risk-based PRGs were calculated for dioxins/furans [expressed as 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalency quotient (TEQ)], carcinogenic polycyclic aromatic hydrocarbons (PAHs) [expressed as the benzo(a)pyrene (BAP) TEQ], total polychlorinated biphenyls (PCBs) (calculated based on total Aroclors), antimony, copper, iron, and manganese in soil. Example calculations for 2,3,7,8-TCDD TEQ, BAP TEQ, and total PCBs are included in Attachment 2 of Appendix A.2. A guidance value was used for lead, as discussed herein. The following table provides a summary of the COCs that are contributing to potentially unacceptable risks for receptors exposed to soil (see Table 1-3 for COC exposure point concentrations).

Receptor	Media	Chemical of Concern
Industrial Worker(1)(2)	Subsurface Soil	Dioxins/Furans(3)
		Total PCBs
Hypothetical Future Resident(2)	Surface Soil	Lead
	Subsurface Soil	Carcinogenic PAHs(3)
		Dioxins/Furans(3)
		Total PCBs
		Antimony
		Copper
		Iron
		Lead

(1) The industrial worker includes the construction worker and occupational worker.

(2) Not a current exposure scenario for the occupational worker or resident because the site is covered with pavement and not used for residential purposes.

(3) Dioxins/furans are evaluated based on 2,3,7,8-TCDD TEQs and carcinogenic PAHs are evaluated based on BAP TEQs.

Manganese was identified as a COC for subsurface soil in the Remedial Investigation (RI) Report for OU7 (Tetra Tech, July 2011) because risk calculations showed potentially unacceptable inhalation risks for construction workers exposed to subsurface soil based on a conservative 150 day per year exposure scenario. For PRG calculations, a more realistic construction worker exposure frequency of 60 days per year was used, resulting in a manganese PRG concentration of approximately 1,120 mg/kg, which is greater than the current exposure point concentration (EPC) (969 mg/kg); therefore, manganese was removed as a COC in the Feasibility Study (FS) Report.

DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS FOR DIRECT CONTACT WITH SOIL

The assumption was made that exposure to chemicals in soil occurred through incidental ingestion, dermal contact, and inhalation of fugitive dust and volatiles. The incremental lifetime cancer risk (ILCR) is calculated from:

$$ILCR = C_S\left[(Intake_{ing})(CSF_{oral}) + (Intake_{derm})(CSF_{derm}) + (Intake_{inh})(CSF_{inh})\right]$$

and the hazard index (HI) is calculated from:

$$HI = C_S\left[\frac{Intake_{ing}}{RfD_{oral}} + \frac{Intake_{derm}}{RfD_{derm}} + \frac{Intake_{inh}}{RfD_{inh}}\right]$$

where:	C_S	=	chemical concentration in soil (mg/kg)
	$Intake_{ing}$	=	intake through incidental ingestion (kg/kg/day)
	$Intake_{derm}$	=	dermally absorbed dose (kg/kg/day)
	$Intake_{inh}$	=	intake through inhalation (kg/kg/day)
	CSF_{oral}	=	oral cancer slope factor $(mg/kg/day)^{-1}$
	RfD_{oral}	=	oral reference dose (mg/kg/day)
	CSF_{derm}	=	dermal cancer slope factor $(mg/kg/day)^{-1}$
	RfD_{derm}	=	dermal reference dose (mg/kg/day)
	CSF_{inh}	=	inhalation cancer slope factor $(mg/kg/day)^{-1}$
	RfD_{inh}	=	inhalation reference dose (mg/kg/day)

A soil concentration (PRG_{Soil}) corresponding to a target cancer risk (TCR) or target hazard index (THI) can be calculated by rearranging the above equations and solving for the soil concentration. The PRG_{Soil} for carcinogens is calculated from:

$$PRG_{Soil} = \frac{TCR}{\left[(Intake_{Ing})(CSF_{oral}) + (Intake_{derm})(CSF_{derm}) + (Intake_{inh})(CSF_{inh})\right]}$$

and for noncarcinogens:

$$PRG_{Soil} = \frac{THI}{\left[\frac{Intake_{ing}}{RfD_{oral}}\right] + \left[\frac{Intake_{derm}}{RfD_{derm}}\right] + \left[\frac{Intake_{inh}}{RfD_{inh}}\right]}$$

The intake through incidental ingestion of soil is calculated from:

$$Intake_{ing} = \frac{(IR_s)(FI)(EF)(ED)(CF)}{(BW)(AT)}$$

where:	$Intake_{ing}$	=	intake of contaminant from soil (kg/kg/day)

IR_s	=	ingestion rate (mg/day)
FI	=	fraction ingested from contaminated source (dimensionless)
EF	=	exposure frequency (days/yr)
ED	=	exposure duration (yr)
CF	=	conversion factor ($1x10^{-6}$ kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days); for non-carcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

Exposure assumptions used to calculate the intake through incidental ingestion of soil are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU7 (Tetra Tech, July 2011). For the construction worker PRG calculation, a site-specific EF of 60 days/year was used instead of the baseline EF provided in the RI Report for OU7.

The intake from dermal contact with soil is calculated from:

$$Intake_{derm} = \frac{(SA)(AF)(ABS)(CF)(EF)(ED)}{(BW)(AT)}$$

where:			
	$Intake_{derm}$	=	amount of chemical absorbed during contact with soil (kg/kg/day)
	SA	=	skin surface area available for contact (cm^2/day)
	AF	=	skin adherence factor (mg/cm^2)
	ABS	=	absorption factor (dimensionless)
	CF	=	conversion factor ($1x10^{-6}$ kg/mg)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	BW	=	body weight (kg)
	AT	=	averaging time (days); for non-carcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

Exposure assumptions used to calculate the intake through dermal contact of soil are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU7 (Tetra Tech, July 2011). For the construction worker PRG calculation, a site-specific EF of 60 days/year was used instead of the baseline EF provided in the RI Report for OU7.

The intake through inhalation of chemicals that have volatilized from soil is calculated from:

$$\text{Intake}_{inh} = \frac{(IR_a)(ET)EF)(ED)}{(BW)(AT)}\left[\frac{1}{VF} + \frac{1}{PEF}\right]$$

where:	Intake_{inh}	=	intake of chemical from air via inhalation (kg/kg/day)
	IR_a	=	inhalation rate (m^3/hr)
	ET	=	exposure time (hours/day)
	EF	=	exposure frequency (days/yr)
	ED	=	exposure duration (yr)
	VF	=	volatilization factor (m^3/kg)
	PEF	=	particulate emission factor (m^3/kg)
	BW	=	body weight (kg)
	AT	=	averaging time (days); for non-carcinogens, AT = ED x 365 days/yr; for carcinogens, AT = 70 yr x 365 days/yr

The particulate emissions factor (PEF) relates the concentration of the chemical in soil with the concentration of dust particles in air. A PEF value of $9.37\text{x}10^{+9}$ m^3/kg was obtained from United States Environmental Protection Agency's (USEPA's) Soil Screening Internet site located at http://rais.ornl.gov/epa/ssl1.shtml. This is the default value for Portland, Maine, which is the closest city to Portsmouth listed on the internet site. Because air emissions resulting from fugitive dust emissions settings will be different than dust emissions generated during construction activities, a separate PEF was used for construction activities. The PEF for construction workers ($1.43\text{x}10^{+6}$ m^3/kg) was calculated using the equations presented in the USEPA's Supplemental Guidance for Developing Soil Screening Levels for Superfund sites (USEPA, December 2002). The volatilization factor (VF) is chemical specific and was also calculated using the methodology present in the Soil Screening guidance. Exposure assumptions used to calculate the intake through inhalation of fugitive dust and volatiles are presented in the PRG calculations spreadsheets and in Appendix D of the RI Report for OU7 (Tetra Tech, July 2011).

PRGs for residential exposure to subsurface soil were developed based on a cumulative target ILCR level of $1\text{x}10^{-4}$. There are three carcinogenic COCs (dioxins/furans, carcinogenic PAHs, and total PCBs) for residential exposure to subsurface soil; therefore, development of residential PRGs for carcinogenic COCs was based on a target ILCR of $3.3\text{x}10^{-5}$ for each COC so that the cumulative target ILCR would be $1\text{x}10^{-4}$ or less. The target ILCR was set at the least conservative end ($1\text{x}10^{-4}$) of USEPA's acceptable ILCR range ($1\text{x}10^{-6}$ to $1\text{x}10^{-4}$) for residential exposure to subsurface soil because current and foreseeable future site use is industrial and residential exposures to subsurface soil based on the exposure parameters used in the human health risk assessment (i.e., 350 day per year) are improbable. Total PCBs are the only COC for which carcinogenic risk may be an issue due to an area of elevated subsurface soil concentrations (depicted on Figure A-3 in Appendix A.2). Unlike the hypothetical future resident it is probable that an industrial worker (e.g. construction worker excavating or occupational worker exposure to excavated soil) could be exposed to subsurface soil; therefore, the target ILCR was set at $1x10^{-5}$ in the middle of the USEPA acceptable ILCR range ($1x10^{-6}$ to $1x10^{-4}$). Non-carcinogenic were developed so that cumulative target HIs for a given target organ or system are equal to one. For example, two of the subsurface soil COCs for the hypothetical future resident, copper and iron, adversely affect the gastrointestinal system; therefore, the target hazard index was set as 0.5 when developing a PRG for each of those COCs so that the cumulative HI affecting the gastrointestinal system would not exceed 1.

A cancer slope factor (CSF) has not been established for 2,3,7,8-TCDD; therefore, a carcinogenic PRG will not be calculated for dioxins/furans as discussed in the responses to USEPA comments dated August 14 and December 11, 2012 included in Appendix F of the FS Report.

The PRGs are presented in Section 2.4 of the FS Report. The methodology for calculating carcinogenic PRGs was performed in accordance with USEPA risk assessment guidance (USEPA, March 2005a and March 2005b).

DEVELOPMENT OF PRELIMINARY REMEDIATION GOAL FOR LEAD

The Office of Solid Waste and Emergency Response (OSWER) soil screening level of 400 mg/kg for residential land use (USEPA, July 1994) was used as the PRG for residents.

PRELIMINARY REMEDIATION GOALS SELECTED FOR OU7

The PRGs selected for OU7 are summarized in the table below.

COC	PRG for Receptor(1) (mg/kg)		
	Industrial Worker(2)	Resident	Basis
Antimony	NA	31	Site-specific risk-based; non-carcinogen based on HI = 1 (Target organ/system = blood)
Copper	NA	1,500	Site-specific risk-based; non-carcinogen based on HI = 0.5 (Target organ/system = gastrointestinal system)
Dioxins/Furans(3)	0.0006	0.000051	Site-specific risk-based; non-carcinogen based on HI = 1 (Target organ/system = reproductive and thyroid)
Iron	NA	27,000	Site-specific risk-based; non-carcinogen based on HI = 0.5 (Target organ/system = gastrointestinal system)
Lead	NA	400	OSWER Directive 9355.4-12

COC	PRG for Receptor[1] (mg/kg)		
	Industrial Worker[2]	Resident	Basis
Carcinogenic PAHs[3]	NA	0.5	Site-specific risked-based; carcinogen based on ILCR of 3.3×10^{-5} for residents
Total PCBs	7.4	7.3	Site-specific risked-based; carcinogen based on ILCR of 3.3×10^{-5} for residents and 1×10^{-5} for industrial workers

NA – Not applicable: PRG is not required because potential risks are acceptable for this receptor for this COC.

(1) PRGs are goals for representative exposure concentrations for an exposure unit and are not intended as pick-up levels. It is possible for a COC to remain on site at concentrations greater than the corresponding EPCs while still being protective of human health and the environment, provided the EPC for that COC is less than the listed PRG.
(2) The industrial worker includes the construction worker and occupational worker, and the value presented is the lower of the two PRG concentrations calculated for those receptors. The occupational worker values were lower for both dioxins/furans and total PCBs.
(3) Dioxins/furans are evaluated based on 2,3,7,8-TCDD TEQs and carcinogenic PAHs are evaluated based on BAP TEQs.

UNCERTAINTY EVALUATION FOR PRG FOR TOTAL PCBs

The selected PRG for total PCBs for OU7 was developed based on potential cancer risks. The following discusses potential uncertainty in the PRG for total PCBs and potential impact to risk management for OU7. To support the evaluation, cancer and non-cancer PRGs for total PCBs are calculated and presented in Appendix A.1.

For OU7, PRGs for PCBs were developed for total PCBs rather than for Aroclor-1248 and Aroclor-1260, which were the specific PCB risk drivers identified in the RI Report for OU7. Aroclors are mixtures of PCBs congeners that were manufactured in the United States prior to 1978 (i.e. production was banned in the United States in 1977). In the environment, PCBs occur as mixtures of congeners, but their composition differs from the commercial mixtures (i.e. Aroclors). This is because after release into the environment, the composition of PCB mixtures changes over time, through partitioning, chemical transformation, and preferential bioaccumulation (USEPA, September 1996).

The selected PRG for total PCBs for OU7 was based on an ILCR developed using a cancer slope factor (CSF) based on an Aroclor mixture that contained overlapping groups of congeners that, together, span the range of congeners most often found in environmental mixtures (USEPA, 1997). Tier I RfDs based on an Aroclor mixture or Aroclor-1260 are not available; therefore, the Tier I RfD for Aroclor-1254 was used as a surrogate for calculation of a non-carcinogen PRG for total PCBs. Although the RfD for Aroclor-1254 may be used as a surrogate for Aroclor-1260 or total PCBs to calculate non-cancer risks, there is uncertainty when using a surrogate value, in this case because the RfD was not based on the compound being evaluated. Furthermore, the Aroclor-1254 RfD is based on that particular compound and as stated above the composition of the congeners within a given Aroclor varies over time in the environment due to processes such as partitioning and chemical transformation which adds additional uncertainty, because even though an Aroclor was detected in soil it is very likely the congener composition is not the same as the original manufactured compound.

The PRG for total PCBs based on potential carcinogenic risks is 7.4 mg/kg for an industrial worker and 7.3 mg/kg for a hypothetical resident. A non-carcinogenic total PCB PRG calculated using the Aroclor-1254 RfD as a surrogate would be 11 mg/kg for an industrial worker and 1 mg/kg for a hypothetical resident. The total PCB PRG based on potential carcinogenic risks was selected instead of the non-cancer PRG because the toxicity value used to calculate the total PCB carcinogenic risk (i.e., CSF) is based on a study that used a mixture of Aroclors which spans the range of congeners likely to be found in the environment whereas the non-cancer toxicity value (i.e., RfD) was based on a study that used a specific manufactured Aroclor (i.e., Aroclor-1254) which is unlikely to be present unaltered in the environment (i.e., the congener mixture changes as the compound weathers in the environment). In summary, the carcinogenic PRG was chosen because the carcinogenic toxicity value used to calculate risk is based on a PCB congener mixture more likely to be found in the environment then the PCB compound (Aroclor-1254) used to determine the non-cancer toxicity value.

Total PCB concentrations only exceeded the carcinogenic total PCB PRG in subsurface soil samples at TP-SB14, TP-SB108, and TP-SB112 as shown on Figures A-5 and A-6 in Appendix A.2. These borings encompass the excavation area described under Alternative 3 in the FS. Outside of this area, except for the maximum total PCB concentration of 1.5 mg/kg, total PCB concentrations were less than 1 mg/kg (see Figure 4-4 in the RI Report for OU7). Post-remedial EPCs based on removal of the excavation area under Alternative 3 were estimated in Appendix A.2. As shown in Table A.2-4, the estimated EPC for total PCBs is 0.13 mg/kg. Therefore, the post-remedial EPC for total PCBs would be less than either the carcinogen or non-carcinogen based total PCB PRGs.

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RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR CONSTRUCTION WORKERS (PAGE ONE OF TWO)

SITE NAME: PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE
EXPOSURE POINT: OPERABLE UNIT 7
EXPOSURE SCENARIO: CONSTRUCTION WORKERS
MEDIA: SUBSURFACE SOIL
DATE: MAY 6, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SOIL.
THE INCIDENTAL INGESTION, DERMAL CONTACT, AND INHALATION ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATION:

Carcinogens

$$PRG_{soil} = \frac{TCR}{IntakeFac_{oral} \cdot CSF_{oral} + IntakeFac_{derm} \cdot CSF_{derm} + IntakeFac_{inh} \cdot CSF_{inh}}$$

NonCarcinogens

$$PRG_{soil} = \frac{THI}{\left(\frac{IntakeFac_{oral}}{RfD_{oral}}\right) + \left(\frac{IntakeFac_{derm}}{RfD_{derm}}\right) + \left(\frac{IntakeFac_{inh}}{RfD_{inh}}\right)}$$

$$IntakeFac_{oral} = \frac{IR \times EF \times ED \times FI \times CF}{BW \times AT}$$

$$IntakeFac_{derm} = \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

$$IntakeFac_{inh} = \frac{EF \times ED \times ET \times (1/VF + 1/PEF)}{AT \times 24 \text{ Hours/day}}$$

WHERE:

PRG = :		Concentration in soil (mg/kg)
TCR = :	1.0E-05	Target Cancer Risk
THI = :	1	Target Hazard Index
IR = :	330	Soil Ingestion Rate (mg/day)
CF = :	1.0E-06	Conversion Factor (kg/mg)
FI = :	1	Fraction from contaminated source (unitless)
SA = :	3300	Skin surface available for contact (cm^2/day)
AF = :	0.3	Soil to skin adherence factor (mg/cm^2)
ABS = :	Chemical Specific	Absorption factor (unitless)
ET = :	8	Exposure time (hr/day)
EF = :	60	Exposure Frequency (days/year)
ED = :	1	Exposure Duration (years)
BW = :	70	Body Weight (kg)
ATc = :	25,550	Averaging time for carcinogenic exposures (days)
ATn = :	365	Averaging time for noncarcinogenic exposures (days)
PEF = :	1.43E+06	Particulate emission factor (m^3/kg)
VF = :	Chemical Specific	Volatilization Factor (m^3/kg)

CHEMICAL	ABS	Cancer Slope Factor			Reference Dose		
		Oral (mg/kg/day)$^{-1}$	Dermal (mg/kg/day)$^{-1}$	Inhalation (ug/m^3)$^{-1}$	Oral (mg/kg/day)	Dermal (mg/kg/day)	Inhalation (mg/m^3)
Total PCB	0.14	2.0E+00	2.0E+00	5.7E-04	2.0E-05	2.0E-05	NA
2,3,7,8-TCDD TEQ	0.03	1.3E+05	1.3E+05	3.8E+01	7.0E-10	7.0E-10	4.0E-08
Manganese	0.04	NA	NA	NA	2.4E-02	9.6E-04	5.0E-05

CHEMICAL	Carcinogenic Intake Factors			Noncarcinogenic Intakes Factors		
	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)
Total PCB	1.11E-08	4.65E-09	5.47E-10	7.75E-07	3.25E-07	3.83E-08
2,3,7,8-TCDD TEQ	1.11E-08	9.96E-10	5.47E-10	7.75E-07	6.97E-08	3.83E-08
Manganese	1.11E-08	1.33E-09	5.47E-10	7.75E-07	9.30E-08	3.83E-08

CHEMICAL	Soil Concentration	
	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
Total PCB	315	18
2,3,7,8-TCDD TEQ	NA	8.3E-04
Manganese	NA	1117

NA = Not applicable

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR CONSTRUCTION WORKERS (PAGE TWO OF TWO)

CALCULATION OF AMBIENT AIR CONCENTRATION
SOURCE: U.S. EPA SOIL SCREENING GUIDANCE

Purpose: To calculate ambient air concentrations resulting from fugitive dust and volatilization from soil.

Relevant Equations:

$$Cair = Cs \times (1/PEF + 1/VF)$$

$$PEF = \frac{3600}{0.036 \times (1 - V) \times (U_m / U_t)^3 \times F(x)}$$

$$VF = \frac{Q/C \times (3.14 \times DA \times T)^{1/2} \times 10^{-4}\ m^2/cm^2}{2 \times pb \times DA}$$

$$DA = \frac{[(\theta a^{10/3} \times Di \times H + \theta w^{10/3} \times Dw)/n^2)]}{pb \times Kd + \theta w + \theta a \times H}$$

$$Csat = S/pb \times (Kd \times pb + \theta w + H \times \theta a)$$

INPUT PARAMETERS		
Parameter	**Value**	**Definition**
Q/C = :	14.31	Inverse of mean conc. at center of source (g/m^2-s per kg/m^3).
T = :	3.2E+07	Exposure interval (seconds).
pb = :	1.5	Dry soil bulk density (g/cm^3).
ps = :	2.65	Soil particle density (g/cm^3).
n = :	0.434	Total soil porosity (L_{pore}/L_{soil}).
θw = :	0.15	Water-filled soil porosity (L_{pore}/L_{soil}).
θa = :	0.284	Air-filled soil porosity (L_{air}/L_{soil}).
Di = :	Chemical specific	Diffusivity in air (cm^2/sec).
H' = :	Chemical specific	Dimensionless Henry's Law Constant.
Dw = :	Chemical specific	Diffusivity in water (cm^2/sec).
DA = :	Chemical specific	Apparent diffusivity (cm^2/sec).
Kd = :	Chemical specific	Soil-water partition coefficient (cm^3/g).
Koc = :	Chemical specific	Soil organic carbon partition coefficient (cm^3/g).
foc = :	0.006	Fraction organic carbon in soil (g/g).

Chemical	Volatile	Chemical Properties					Intermediate Calculations			
		Koc (cm^3/g)	**Di (cm^2/sec)**	**Dw (cm^2/sec)**	**S (mg/L)**	**H'**	**Kd (cm^3/g)**	**Da (cm^2/sec)**	**VF (m^3/kg)**	**Csat (mg/kg)**
Soil										
Total PCB	N	NA	NA	NA	NA	NA	NA	NA	1.0E+99	NA
2,3,7,8-TCDD Equivalents	N	NA	NA	NA	NA	NA	NA	NA	1.0E+99	NA
Manganese	N	NA	NA	NA	NA	NA	NA	NA	1.00E+99	NA

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR OCCUPATIONAL WORKERS (PAGE ONE OF TWO)

SITE NAME: PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE
EXPOSURE POINT: OPERABLE UNIT 7
EXPOSURE SCENARIO: OCCUPATIONAL WORKERS
MEDIA: SUBSURFACE SOIL
DATE: MAY 6, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SOIL.
THE INCIDENTAL INGESTION, DERMAL CONTACT, AND INHALATION ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATION:

Carcinogens

$$PRG_{soil} = \frac{TCR}{IntakeFac_{oral} \cdot CSF_{oral} + IntakeFac_{derm} \cdot CSF_{derm} + IntakeFac_{inh} \cdot CSF_{inh}}$$

NonCarcinogens

$$PRG_{soil} = \frac{THI}{\left(\frac{IntakeFac_{oral}}{RfD_{oral}}\right) + \left(\frac{IntakeFac_{derm}}{RfD_{derm}}\right) + \left(\frac{IntakeFac_{inh}}{RfD_{inh}}\right)}$$

$$IntakeFac_{oral} = \frac{IR \times EF \times ED \times FI \times CF}{BW \times AT}$$

$$IntakeFac_{derm} = \frac{SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$$

$$IntakeFac_{inh} = \frac{EF \times ED \times ET \times (1/VF + 1/PEF)}{AT \times 24 \text{ Hours/day}}$$

WHERE:

PRG	= :		Concentration in soil (mg/kg)
TCR	= :	1.0E-05	Target Cancer Risk
THI	= :	1	Target Hazard Index
IR	= :	100	Soil Ingestion Rate (mg/day)
CF	= :	1.0E-06	Conversion Factor (kg/mg)
FI	= :	1	Fraction from contaminated source (unitless)
SA	= :	3300	Skin surface available for contact (cm^2/day)
AF	= :	0.2	Soil to skin adherence factor (mg/cm^2)
ABS	= :	Chemical Specific	Absorption factor (unitless)
ET	= :	8	Exposure time (hr/day)
EF	= :	250	Exposure Frequency (days/year)
ED	= :	25	Exposure Duration (years)
BW	= :	70	Body Weight (kg)
ATc	= :	25,550	Averaging time for carcinogenic exposures (days)
ATn	= :	9,125	Averaging time for noncarcinogenic exposures (days)
PEF	= :	9.37E+09	Particulate emission factor (m^3/kg)
VF	= :	Chemical Specific	Volatilization Factor (m^3/kg)

CHEMICAL	ABS	Cancer Slope Factor			Reference Dose		
		Oral $(mg/kg/day)^{-1}$	Dermal $(mg/kg/day)^{-1}$	Inhalation $(ug/m^3)^{-1}$	Oral (mg/kg/day)	Dermal (mg/kg/day)	Inhalation (mg/m^3)
Total PCB	0.14	2.0E+00	2.0E+00	5.7E-04	2.0E-05	2.0E-05	NA
2,3,7,8-TCDD TEQ	0.03	1.3E+05	1.3E+05	3.8E+01	7.0E-10	7.0E-10	4.0E-08

CHEMICAL	Carcinogenic Intake Factors			Noncarcinogenic Intakes Factors		
	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)	Oral (kg/kg/day)	Dermal (kg/kg/day)	Inhalation (kg/m^3)
Total PCB	3.49E-07	3.23E-07	8.70E-12	9.78E-07	9.04E-07	2.44E-11
2,3,7,8-TCDD TEQ	3.49E-07	6.92E-08	8.70E-12	9.78E-07	1.94E-07	2.44E-11

CHEMICAL	Soil Concentration	
	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
Total PCB	7.44	11
2,3,7,8-TCDD TEQ	NA	6.0E-04

NA = Not applicable

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR OCCUPATIONAL WORKERS (PAGE TWO OF TWO)

CALCULATION OF AMBIENT AIR CONCENTRATION
SOURCE: U.S. EPA SOIL SCREENING GUIDANCE

Purpose: To calculate ambient air concentrations resulting from fugitive dust and volatilization from soil.

Relevant Equations:

$$Cair = Cs \times (1/PEF + 1/VF)$$

$$VF = \frac{Q/C \times (3.14 \times DA \times T)^{1/2} \times 10^{-4}\ m^2/cm^2}{2 \times pb \times DA}$$

$$DA = \frac{[(\theta a^{10/3} \times Di \times H + \theta w^{10/3} \times Dw)/n^2)]}{pb \times Kd + \theta w + \theta a \times H}$$

$$Csat = S/pb \times (Kd \times pb + \theta w + H \times \theta a)$$

$$PEF = \frac{3600}{0.036 \times (1 - V) \times (U_m / U_t)^3 \times F(x)}$$

INPUT PARAMETERS		
Parameter	**Value**	**Definition**
Q/C = :	74.3185	Inverse of mean conc. at center of source (g/m^2-s per kg/m^3).
T = :	9.5E+08	Exposure interval (seconds).
pb = :	1.5	Dry soil bulk density (g/cm^3).
ps = :	2.65	Soil particle density (g/cm^3).
n = :	0.434	Total soil porosity (L_{pore}/L_{soil}).
θw = :	0.15	Water-filled soil porosity (L_{pore}/L_{soil}).
θa = :	0.284	Air-filled soil porosity (L_{air}/L_{soil}).
Di = :	Chemical specific	Diffusivity in air (cm^2/sec).
H' = :	Chemical specific	Dimensionless Henry's Law Constant.
Dw = :	Chemical specific	Diffusivity in water (cm^2/sec).
DA = :	Chemical specific	Apparent diffusivity (cm^2/sec).
Kd = :	Chemical specific	Soil-water partition coefficient (cm^3/g).
Koc = :	Chemical specific	Soil organic carbon partition coefficient (cm^3/g).
foc = :	0.006	Fraction organic carbon in soil (g/g).

Chemical	Volatile	Chemical Properties					Intermediate Calculations			
		Koc (cm^3/g)	**Di (cm^2/sec)**	**Dw (cm^2/sec)**	**S (mg/L)**	**H'**	**Kd (cm^3/g)**	**Da (cm^2/sec)**	**VF (m^3/kg)**	**Csat (mg/kg)**
Surface Soil										
Total PCB	N	NA	NA	NA	NA	NA	NA	NA	1.0E+99	NA
2,3,7,8-TCDD TEQ	N	NA	NA	NA	NA	NA	NA	NA	1.0E+99	NA

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR RESIDENTS (PAGE ONE OF TWO)

SITE NAME: PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE
EXPOSURE POINT: OPERABLE UNIT 7
EXPOSURE SCENARIO: LIFELONG RESIDENTS
MEDIA: SURFACE/SUBSURFACE SOIL
DATE: APRIL 29, 2013

THIS SPREADSHEET CALCULATES RISK-BASED CLEANUP GOALS FOR EXPOSURES TO SOIL.
THE INCIDENTAL INGESTION, DERMAL CONTACT, AND INHALATION ROUTES OF EXPOSURE ARE CONSIDERED.

RELEVANT EQUATIONS:

Carcinogens

$$RBC_{soil} = \frac{TCR}{Intake_{oral} \cdot CSF_{oral} + Intake_{derm} \cdot CSF_{derm} + EC_{air} \cdot IUR}$$

Noncarcinogens

$$RBC_{soil} = \frac{THI}{\left(\frac{Intake_{oral}}{RfD_{oral}}\right) + \left(\frac{Intake_{derm}}{RfD_{derm}}\right) + \left(\frac{EC_{air}}{RfC}\right)}$$

$$Intake_{oral} = \frac{IR \text{ x } EF \text{ x } ED \text{ x } FI \text{ x } CF}{BW \text{ x } AT} \text{ x } ADAF$$

$$Intake_{derm} = \frac{SA \text{ x } AF \text{ x } ABS \text{ x } EF \text{ x } ED \text{ x } CF}{BW \text{ x } AT} \text{ x } ADAF$$

$$EC_{air} = \frac{ET \text{ x } EF \text{ x } ED \text{ x } [1/PEF + 1/VF]}{AT \text{ x } 24 \text{ hours/day}} \text{ x } ADAF$$

Mutagenic

$$RBC_{soil} = \frac{TCR}{Intake_{ages0-2} + Intake_{ages2-6} + Intake_{ages6-16} + Intake_{ages16-30}}$$

INPUT ASSUMPTIONS:

	Parameter	Child Ages 0 - 2	Child Ages 2 - 6	Adult Ages 6 - 16	Adult Ages 16 - 30	Definition
General	TCR = :	3E-05				Target Cancer Risk
	THI = :	1				Target Hazard Index
	EF = :	350	350	350	350	Exposure Frequency (days/year)
	ED =:	2	4	10	14	Exposure Duration (years)
	BW = :	15	15	70	70	Body Weight (kg)
	ATc = :	25,550				Averaging time for carcinogenic exposures (days)
	ATn = :	730	1,460	3,650	5,110	Averaging time for noncarcinogenic exposures (days)
	CF = :	1.0E-06				Conversion Factor (kg/mg)
	ADAF = :	Chemical Specific				Age Dependent Adjustment Factor
Incidental Ingestion	IR = :	200	200	100	100	Soil Ingestion Rate (mg/day)
	FI = :	1	1	1	1	Fraction from contaminated source (unitless)
Dermal Contact	SA = :	2,800	2,800	5,700	5,700	Skin surface available for contact (cm^2/day)
	AFc = :	0.2	0.2	0.07	0.07	Soil to skin adherence factor (mg/cm^2)
	ABS = :	Chemical Specific				Absorption factor (unitless)
Inhalation	ETc = :	24	24	24	24	Exposure time (hours/day)
	PEF = :	9.37E+09				Particulate emission factor (m^3/kg)
	VF = :	Chemical Specific				Volatilization factor (m^3/kg)

CHEMICAL	ABS	Cancer Slope Factor Oral $(mg/kg/day)^{-1}$	Cancer Slope Factor Dermal $(mg/kg/day)^{-1}$	Cancer Slope Factor Inhalation $(ug/m^3)^{-1}$	Reference Dose Oral (mg/kg/day)	Reference Dose Dermal (mg/kg/day)	Reference Dose Inhalation (mg/m^3)
Total PCB[(2)]	0.14	2.0E+00	2.0E+00	5.7E-04	2.0E-05	2.0E-05	NA
BAP TEQ	0.13	7.3E+00	7.3E+00	1.1E-03	NA	NA	NA
2,3,7,8-TCDD TEQ	0.03	1.3E+05	1.3E+05	3.8E+01	7.0E-10	7.0E-10	4.0E-08
Antimony	0	NA	NA	NA	4.0E-04	4.0E-04	NA
Copper	0	NA	NA	NA	4.0E-02	4.0E-02	NA
Iron	0	NA	NA	NA	7.0E-01	7.0E-01	NA

CHEMICAL	Age Dependent Adjustment Factor Ages 0 - 2	Ages 2 - 6	Ages 6 - 16	Ages >16
Total PCB[(2)]	1	1	1	1
BAP TEQ	10	3	3	1
2,3,7,8-TCDD TEQ	1	1	1	1
Antimony	1	1	1	1
Copper	1	1	1	1
Iron	1	1	1	1

CHEMICAL	Carcinogenic Intake Factors Oral (kg/kg/day)	Carcinogenic Dermal (kg/kg/day)	Carcinogenic Inhalation (kg/m^3)	Noncarcinogenic Intake Factors Oral (kg/kg/day)	Noncarcinogenic Dermal (kg/kg/day)	Noncarcinogenic Inhalation (kg/m^3)
Total PCB[(2)]	1.57E-06	6.92E-07	4.39E-11	1.28E-05	5.01E-06	1.02E-10
BAP TEQ	6.71E-06	2.57E-06	1.11E-10	1.28E-05	4.65E-06	1.02E-10
2,3,7,8-TCDD TEQ	1.57E-06	1.48E-07	4.39E-11	1.28E-05	1.07E-06	1.02E-10
Antimony	1.57E-06	0.00E+00	4.39E-11	1.28E-05	0.00E+00	1.02E-10
Copper	1.57E-06	0.00E+00	4.39E-11	1.28E-05	0.00E+00	1.02E-10
Iron	1.57E-06	0.00E+00	4.39E-11	1.28E-05	0.00E+00	1.02E-10

CHEMICAL	Soil Concentration Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)[(1)]
Total PCB[(2)]	7.31	1
BAP TEQ	0.49	NA
2,3,7,8-TCDD TEQ	1.5E-04	5.1E-05
Antimony	NA	31
Copper	NA	3129
Iron	NA	54750

1 - Noncarcinogenic concentration is based on the child resident.
2 - Aroclor 1254 was used as a surrogate for reference doses.

RISK ASSESSMENT SPREADSHEET - CALCULATION OF RISK-BASED CONCENTRATIONS FOR RESIDENTS (PAGE TWO OF TWO)

CALCULATION OF AMBIENT AIR CONCENTRATION
SOURCE: U.S. EPA SOIL SCREENING GUIDANCE

Purpose: To calculate ambient air concentrations resulting from fugitive dust and volatilization from soil.

Relevant Equations:

$$Cair = Cs \times (1/PEF + 1/VF)$$

$$VF = \frac{Q/C \times (3.14 \times DA \times T)^{1/2} \times 10^{-4}\ m^2/cm^2}{2 \times pb \times DA}$$

$$PEF = \frac{3600}{0.036 \times (1 - V) \times (U_m / U_t)^3 \times F(x)}$$

$$DA = \frac{[(\theta a^{10/3} \times Di \times H + \theta w^{10/3} \times Dw)/n^2)]}{pb \times Kd + \theta w + \theta a \times H}$$

$$Csat = S/pb \times (Kd \times pb + \theta w + H \times \theta a)$$

INPUT PARAMTERS		
Parameter	**Value**	**Definition**
Q/C = :	74.3185	Inverse of mean conc. at center of source (g/m^2-s per kg/m^3).
T = :	9.5E+08	Exposure interval (seconds).
pb = :	1.5	Dry soil bulk density (g/cm^3).
ps = :	2.65	Soil particle density (g/cm^3).
n = :	0.434	Total soil porosity (L_{pore}/L_{soil}).
θw = :	0.15	Water-filled soil porosity (L_{pore}/L_{soil}).
θa = :	0.284	Air-filled soil porosity (L_{air}/L_{soil}).
Di = :	Chemical specific	Diffusivity in air (cm^2/sec).
H' = :	Chemical specific	Dimensionless Henry's Law Constant.
Dw = :	Chemical specific	Diffusivity in water (cm^2/sec).
DA = :	Chemical specific	Apparent diffusivity (cm^2/sec).
Kd = :	Chemical specific	Soil-water partition coefficient (cm^3/g).
Koc = :	Chemical specific	Soil organic carbon partition coefficient (cm^3/g).
foc = :	0.006	Fraction organic carbon in soil (g/g).

Chemical	Volatile	Chemical Properties					Intermediate Calculations			
		Koc (cm^3/g)	Di (cm^2/sec)	Dw (cm^2/sec)	S (mg/L)	H'	Kd (cm^3/g)	Da (cm^2/sec)	VF (m^3/kg)	Csat (mg/kg)
Surface Soil										
Total PCB(2)	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA
BAP TEQ	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA
2,3,7,8-TCDD TEQ	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA
Antimony	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA
Copper	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA
Iron	N	NA	NA	NA	NA	NA	NA	NA	1E+99	NA

APPENDIX A.2

ADDITIONAL RISK EVALUATIONS

APPENDIX A.2
ADDITIONAL RISK EVALUATIONS

Two additional risk evaluations were conducted to support the Operable Unit 7 (OU7) Feasibility Study (FS) Report. The first reevaluates the risk after extending the area of acceptable risk (identified in the Remedial Investigation) from the filled area around Building 237 to the area south of Goodrich Avenue. The second risk evaluation determines the anticipated post-remedial risk remaining at the site if the contaminated soil identified in Alternative 3 (Section 4.2.3 of the FS) was excavated and disposed of off-site.

To assist in the two additional risk evaluations, three exposure scenarios were developed. Exposure Scenario 1 evaluates the entire site as a whole (i.e., one exposure unit) (Figure A-1). Exposure Scenario 2 evaluates the site as two exposure units; the filled area with no debris in the vicinity of former Building 237 (Exposure Unit 1) and the remainder of the site (Exposure Unit 2) as shown on Figure A-2. These exposure units were recommended for evaluation in the Remedial Investigation (RI), because of the difference in fill material chemical concentrations in the area around Building 237 compared to concentrations of chemicals in soil across the remainder of the site. The data in the RI indicated that risk was acceptable for Exposure Unit 1 (filled area with no debris in the vicinity of former Building 237) of Exposure Scenario 2. Exposure Scenario 3 (shown in Figure A-3) modifies the exposure units identified in Scenario 2, to determine if a simpler boundary could be utilized for land use restrictions.

Attachment 1 contains tables that list data sets for the three exposure scenarios evaluated and includes United States Environmental Protection Agency (USEPA) ProUCL Version 4.1 outputs for exposure point concentrations (EPCs) calculated for the FS that were not calculated in the RI Report and for the EPCs calculated for post-remedial datasets. Attachment 2 provides example calculations.

First Evaluation - Risk Evaluation for the Filled Area in the Vicinity of Former Building 237 including the Area South of Goodrich Avenue

In the RI Report, two data sets were evaluated: the entire site data set (Figure A-1), and the filled area in the vicinity of former Building 237 data set (Figure A-2, Exposure Unit 1). The filled area in the vicinity of former Building 237 was evaluated separately from the remaining site samples because this area did not contain debris material and chemical concentrations in this area were found to be statistically significantly different from chemical concentrations in the remaining portion of OU7. The Human Health Risk Assessment (HHRA) conducted in the RI concluded that adverse receptor effects are not anticipated for exposure to soil in the filled area in the vicinity of former Building 237, and the RI recommended that the FS Report for OU7 evaluate remedial options for addressing this area separately from the rest of OU7. Remedial options for addressing the filled area in the vicinity of former Building 237 were evaluated separately from the rest of the site in this FS with the conclusion being made that there are no potentially unacceptable risks to any receptors in that area; therefore, the area should be removed from the OU7 site boundary. This appendix includes an evaluation of a third data set that covers the filled area in the vicinity of former Building 237 and samples in the adjacent area south of Goodrich Avenue (Figure A-3) to determine if risks would still be acceptable if the filled area with no debris in the vicinity of former Building 237 included the adjacent area south of Goodrich Avenue.

The purpose of this evaluation is to determine if potentially unacceptable risks exist in Exposure Unit 1 of Exposure Scenario 3 (i.e. the filled area in the vicinity of former Building 237 including the area south of Goodrich Avenue) by calculating EPCs for site COCs within that area and then comparing those COC EPC concentrations to PRGs. If the EPC concentration for a given COC exceeds its PRG then associated risks would be considered unacceptable. To begin this evaluation, EPCs were calculated for COCs identified under the hypothetical future residential exposure scenario presented in Table 1-3 of this FS for the combined data set of samples from the filled area in the vicinity of former Building 237 and the area south of Goodrich Avenue. For lead the mean concentration of the data set is the EPC. For all other COCs the maximum concentration was used as the EPC because there were not enough subsurface soil samples to calculate a reliable 95% UCL using ProUCL Version 4.1 software. The following table lists the COC EPCs for Exposure Unit 1 of Exposure Scenario 3 compared to site PRGs.

Table A-2.1: Comparison of COC PRGs to EPCs for Exposure Scenario 3 Exposure Unit 1

COC	PRG		EPCs for Exposure Scenario 3 (mg/kg)	
			Exposure Unit 1 - Vicinity of Building 237 & South of Goodrich Avenue	
	Industrial	Residential	Surface Soil	Subsurface Soil
BAP TEQ(1)	---(2)	0.5	---(2)	0.24(4)
Total PCBs(1)	7.4	7.3	---(2)	0.2(4)
2,3,7,8-TCDD TEQ(1)	0.0006	0.000051	---(2)	---(5)
Antimony	---(2)	31	---(2)	---(6)
Copper	---(2)	1,500	---(2)	102(4)
Iron	---(2)	27,000	---(2)	22,500(4)
Lead	---(2)	400	270(3)	119(3)

1. Carcinogenic polycyclic aromatic hydrocarbons (PAHs) were represented in terms of benzo(a)pyrene (BAP) toxicity equivalency quotients (TEQs), which are calculated concentrations for each sample that normalizes the concentration of each carcinogenic PAH to equal the toxicity equivalent concentration of BAP, the most toxic carcinogenic PAH. Likewise, the 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) TEQ and total polychlorinated biphenyls (PCBs) were calculated for each sample and utilized to represent dioxins/furans and Aroclors, respectively. The BAP TEQ, 2,3,7,8-TCDD TEQ, and total PCB calculated results were used to calculate EPCs for this evaluation because PRGs developed in this FS were based upon those same calculated parameters. Example calculations for BAP TEQ, 2,3,7,8-TCDD TEQ and total PCBs are in Attachment 2 of this appendix.

2. A PRG or EPC was not calculated because this was not a COC for this receptor or matrix.

3. Mean lead concentration was used to represent the EPC.

4. The maximum concentration was used to represent the EPC.
5. No samples in this exposure unit were analyzed for dioxins/furans.
6. All subsurface soil antimony results for this exposure unit were reported as non-detected.

No unacceptable risks are anticipated for Exposure Unit 1 of Exposure Scenario 3 (i.e., filled area with no debris in the vicinity of former Building 237 and the area south of Goodrich Avenue) for current or future industrial and residential users because none of the COC EPC concentrations exceed corresponding PRGs as shown above in Table A-2.1. Therefore, excluding the area south of Goodrich Avenue from land use restrictions, as shown on Figure A-3, would not result in unacceptable risks and could be considered to provide a simpler boundary for implementation of land use restrictions.

Second Evaluation - Estimated Post-Remedial Exposure Point Concentrations for Alternative 3

An evaluation of potential human health risks at OU7 following excavation of soil as presented under Alternative 3 (Section 4.2.3 of the FS) was conducted. The purpose of this evaluation is to compare the estimated post-remedial EPCs for COCs to corresponding PRGs in order to estimate if implementation of Alternative 3 would result in COC concentrations less than PRGs. Scenarios 1, 2, and 3, described previously, were evaluated (see Figures A-1 through A-3). To begin this evaluation, OU7 PRGs were compared to EPCs for COCs under each of three exposure scenarios to provide a baseline (Table A.2-2). Figures A-4 and A-5 show the locations of COC concentrations exceeding residential PRGs in surface and subsurface soil, respectively. Figure A-6 shows the locations of COC concentrations exceeding industrial PRGs in subsurface soil.

To evaluate estimated post-remedial risks, EPCs for COCs were recalculated by substituting COC concentrations with November 2012 USEPA residential Regional Screening Levels (RSLs) based on an incremental lifetime cancer risk (ILCR) of $1x10^{-6}$ for carcinogens or an HQ of 0.1 for non-carcinogens for those sample locations in the Alternative 3 excavation areas to reflect potential COC concentrations following the remedial action. Using USEPA residential RSLs as the substitution concentrations for COCs is considered conservative because backfill concentrations would likely be less than USEPA residential RSL concentrations for the COCs. Pre-excavation (i.e., current) and estimated post-excavation concentrations of COCs for sample locations within the Alternative 3 excavation areas are presented on Table A.2-3. Chemical concentrations of COCs that were less than the RSLs or non-detected results were not changed for the post-excavation concentration. Post-remedial EPC calculations are provided in Attachment 1.

Table A.2-4 presents a comparison of the post-remedial EPCs for Scenarios 1, 2, and 3 to the PRGs calculated in Appendix A.1. As shown on Table A.2-4, no post-remedial EPCs for subsurface soil exceed industrial worker PRGs; therefore, no unacceptable risks are anticipated for industrial workers exposed to surface or subsurface soil following the excavation proposed in Alternative 3. The estimated post-remedial surface soil EPCs for lead in all three scenarios are less than the residential PRG; therefore, this evaluation estimates that there would be no unacceptable risks to residents exposed to surface soil if Alternative 3 were implemented. However, subsurface soil EPCs for some of the COCs exceed residential PRGs. Based on this evaluation subsurface soil land use controls (LUCs) would be necessary for residential exposure after implementation of Alternative 3 for Exposure Scenario 1 and for Exposure Unit 2 in Exposure Scenarios 2 and 3 because COC concentrations are estimated to exceed residential PRGs in subsurface soil.

TABLE A.2-2
COMPARISON OF PRGS TO PRE-REMEDIAL EPCS
OPERABLE UNIT 7 FEASABILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

COC	PRG[1][2]		EPCs for Exposure Scenario 1 (mg/kg)		EPCs for Exposure Scenario 2 (mg/kg)				EPCs for Exposure Scenario 3 (mg/kg)			
			Entire Site[3]		Exposure Unit 1 - Vicinity of Building 237[4]		Exposure Unit 2 - Remainder of Site[5]		Exposure Unit 1 - Vicinity of Building 237 & South of Goodrich Avenue[6]		Exposure Unit 2 - Remainder of Site[7]	
	Industrial[8]	Residential	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
BAP TEQ[9]	(10)	0.5	---[10]	1.1	---[10]	---[10]	---[10]	0.85	---[10]	0.24[12]	---[10]	1.2
Total PCBs	7.4	7.3	---[10]	6.3	---[10]	---[10]	---[10]	6.5	---[10]	0.2[12]	---[10]	6.6
2,3,7,8-TCDD TEQ[11]	0.0006	0.000051	---[10]	0.0013	---[10]	---[10]	---[10]	0.0014	---[10]	---[14]	---[10]	0.0014
Antimony	(10)	31	---[10]	182	---[10]	---[10]	---[10]	281	---[10]	---[15]	---[10]	290
Copper	(10)	1,500	---[10]	6,020	---[10]	---[10]	---[10]	6,168	---[10]	102[12]	---[10]	6,320
Iron	(10)	27,000	---[10]	97,100	---[10]	---[10]	---[10]	98,900	---[10]	23,100[12]	---[10]	101,000
Lead	(10)	400	510[13]	1,600[13]	---[10]	---[10]	582[13]	1,630[13]	270[13]	119[13]	580[13]	1,670[13]

1 - PRGs are EPCs, not pick-up levels. It is possible for concentrations of a COC to remain on-site at concentrations greater than the corresponding EPCs while still being protective of human health and the environment provided the EPC for that COC is less than the listed PRG.
2 - See Appendix A-1 for PRG calculation methodology.
3 - EPCs (and COPC selection tables) for Exposure Scenario 1 - Entire Site are presented in the RI Report (Tetra Tech, 2011).
4 - EPCs (and COPC selection tables) for Exposure Scenario 2, Exposure Unit 1 - Vicinity of Building 237 are presented in the RI Report (Tetra Tech, 2011). No COCs were identified for this exposure unit.
5 - EPCs for Scenario 2, Exposure Unit 2 were calculated in Appendix A.2 of the FS (see Attachment 1). EPCs are presented for those chemicals identified as COCs in Exposure Scenario 1.
6 - EPCS for Exposure Scenario 3, Exposure Unit 1 are presented for those chemicals identifed as COCs in Exposure Scenario 1 to demonstrate that there are no COC EPC concentrations greater than PRGs in this exposure unit.
7 - EPCs for Exposure Scenario 3, Exposure Unit 2 were calculated in Appendix A.2 of the FS (see Attachment 1). EPCs are presented for those chemicals that were identified as COCs in Exposure Scenario 1.
8 - The Industrial PRG accounts for the construction worker and occupational worker.
9 - The carcinogenic PAHs are represented by the BAP TEQ.
10 - The chemical is not a COC or COPC for the identified receptor, scenario, and medium.
11 - Dioxins/furans are represented by the 2,3,7,8-TCDD TEQ.
12 - The maximum concentration was used as the EPC.
13 - The mean concentration was used as the EPC.
14 - No samples in this exposure unit were analyzed for dioxins/furans.
15 - All subsurface soil antimony results for this exposure unit were reported as non-detected.

BAP = benzo(a)pyrene
COC = chemical of concern
COPC = chemical of potential concern
EPC = exposure point concentration
FS = Feasibility Study
mg/kg = milligram per kilogram
PCB = polychlorinated biphenyl
PRG = preliminary remediation goal
RI = Remedial Investigation
TCDD = tetrachlorodibenzo-p-dioxin
TEQ = toxicity equivalency quotient

TABLE A.2-3
SUMMARY OF PRE-EXCAVATION CONCENTRATIONS AND ESTIMATED POST-EXCAVATION CONCENTRATIONS FOR COCs IN ALTERNATIVE 3 EXCAVATION AREAS
OPERABLE UNIT 7 FEASABILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Medium	Sample Location	Sample ID	COC	Concentration (mg/kg)	
				Pre-excavation	Post-excavation[1]
Surface Soil	TP-SB27	TPSS270001	Lead	13200 J	400
	TP-SB112	TPSS1120001	Lead	NA	NA
	TP-SB108	TPSS1080001	Lead	NA	NA
Subsurface Soil	TP-SB27	TPSB270205	BAP TEQ	0.062 U	0.062 U
			Total PCBs	0.063 U	0.063 U
			2,3,7,8-TCDD TEQ	1.68E-03	4.50E-06
			Antimony	0.65 UJ	0.65 UJ
			Copper	352	310
			Iron	114000	5500
			Lead	811	400
		TPSB270508	BAP TEQ	0.071 U	0.071 U
			Total PCBs	0.070 U	0.070 U
			2,3,7,8-TCDD TEQ	3.75E-06	3.75E-06
			Antimony	0.27 UJ	0.27 UJ
			Copper	17.3	17.3
			Iron	23400	5500
			Lead	46.1	46.1
	TP-SB112	TPSB1120205	BAP TEQ	NA	NA
			Total PCBs	0.29	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	NA	NA
			Copper	NA	NA
			Iron	NA	NA
			Lead	NA	NA
		TPSB1120508	BAP TEQ	NA	NA
			Total PCBs	19	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	NA	NA
			Copper	NA	NA
			Iron	NA	NA
			Lead	NA	NA
	TP-SB14	TP-SB14-0305-98	BAP TEQ	0.39	0.015
			Total PCBs	44	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	1.5 UJ	1.5 UJ
			Copper	17500 J	310
			Iron	190000	5500
			Lead	398 J	398 J
		TP-SB14-0709-98	BAP TEQ	3.69	0.015
			Total PCBs	21	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	0.55 UJ	0.55 UJ
			Copper	12800 J	310
			Iron	117000	5500
			Lead	1100 J	400
	TP-SB108	TPSB1080205	BAP TEQ	NA	NA
			Total PCBs	0.32	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	NA	NA
			Copper	NA	NA
			Iron	NA	NA
			Lead	NA	NA
		TPSB1080508	BAP TEQ	NA	NA
			Total PCBs	41 J	0.22
			2,3,7,8-TCDD TEQ	NA	NA
			Antimony	NA	NA
			Copper	NA	NA
			Iron	NA	NA
			Lead	NA	NA

For samples with duplicate pairs, the average result is shown.

Acronyms:
BAP = benzo(a)pyrene
COC = chemical of concern
ID = identification
ILCR = incremental lifetime cancer risk
HQ = hazard quotient
NA = Not applicable; Not analyzed
PCB = polychlorinated biphenyl
2,3,7,8- TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ = toxicity equivalency quotient

Footnotes:
1 COC concentrations exceeding their corresponding RSLs for the baseline HHRA were replaced with residential RSL concentrations (based on an ILCR of $1x10^{-6}$ for carcinogens or an HQ of 0.1 for non-carcinogens) for sample locations expected to be excavated to complete the post-excavation risk evaluation. Using RSLs as representative post-excavation concentrations for sample locations in proposed excavation areas is considered conservative because backfill would not be contaminated. Therefore, actual COC concentrations for the sample locations post-excavation would be less than corresponding RSLs.

TABLE A.2-4
COMPARISON OF PRGS TO POST-REMEDIAL EPCS
OPERABLE UNIT 7 FEASABILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

COC	PRG(1)(2)		EPC - Scenario 1 (mg/kg)		EPC - Scenario 2 (mg/kg)				EPC - Scenario 3 (mg/kg)			
			Entire Site		Exposure Unit 1 - Vicinity of Building 237		Exposure Unit 2 - Remainder of Site		Exposure Unit 1 - Vicinity of Building 237 & South of Goodrich Ave.		Exposure Unit 2 - Remainder of Site	
	Industrial(3)	Residential	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil	Surface Soil	Subsurface Soil
BAP TEQ(4)	(6)	0.5	(6)	1.0	(6)	(6)	(6)	1.1	(6)	0.24(8)	(6)	1.1
Total PCBs	7.4	7.3	(6)	0.13	(6)	(6)	(6)	0.13	(6)	0.2(8)	(6)	0.13
2,3,7,8-TCDD TEQ(5)	0.0006	0.000051	(6)	0.00001	(6)	(6)	(6)	0.00001	(6)	(9)	(6)	0.00001
Antimony	(6)	31	(6)	182	(6)	(6)	(6)	280	(6)	(10)	(6)	290
Copper	(6)	1,500	(6)	5,480	(6)	(6)	(6)	5,600	(6)	102(8)	(6)	5,750
Iron	(6)	27,000	(6)	91,200	(6)	(6)	(6)	92,800	(6)	23,100(8)	(6)	94,700
Lead	(6)	400	260(7)	1,580(7)	(6)	(6)	290(7)	1,620(7)	270(7)	119(7)	260(7)	1,660(7)

1 - PRGs are goals for representative exposure concentrations for an exposure unit and are not intended as pick-up levels. It is possible for a COC to remain on site at concentrations greater than the corresponding EPCs while still being protective of human health and the environment, provided the EPC for that COC is less than the listed PRG.
2 - See Appendix A-1 for PRG calculation methodology.
3 - The Industrial PRG includes the construction worker and occupational worker.
4 - The carcinogenic PAHs are represented by BAP TEQs.
5 - Dioxins/furans are represented by 2,3,7,8-TCDD TEQ.
6 - The chemical is not a COC or COPC for the identified receptor, scenario, and medium. Post-remedial EPCs were not calculated for chemicals not identified as COCs or COPCs in Table A.2-3.
7 - The mean concentration was used as the EPC.
8 - The maximum concentration was used as the EPC.
9 - No samples in this exposure unit were analyzed for dioxins/furans.
10 - All subsurface soil antimony results for this exposure unit were reported as non-detected.

BAP = benzo(a)pyrene
COC = chemical of concern
COPC = chemical of potential concern
EPC = exposure point concentration
mg/kg = milligram per kilogram
PCB = polychlorinated biphenyl
PRG = preliminary remediation goal
TCDD = tetrachlorodibenzo-p-dioxin
TEQ = toxicity equivalency

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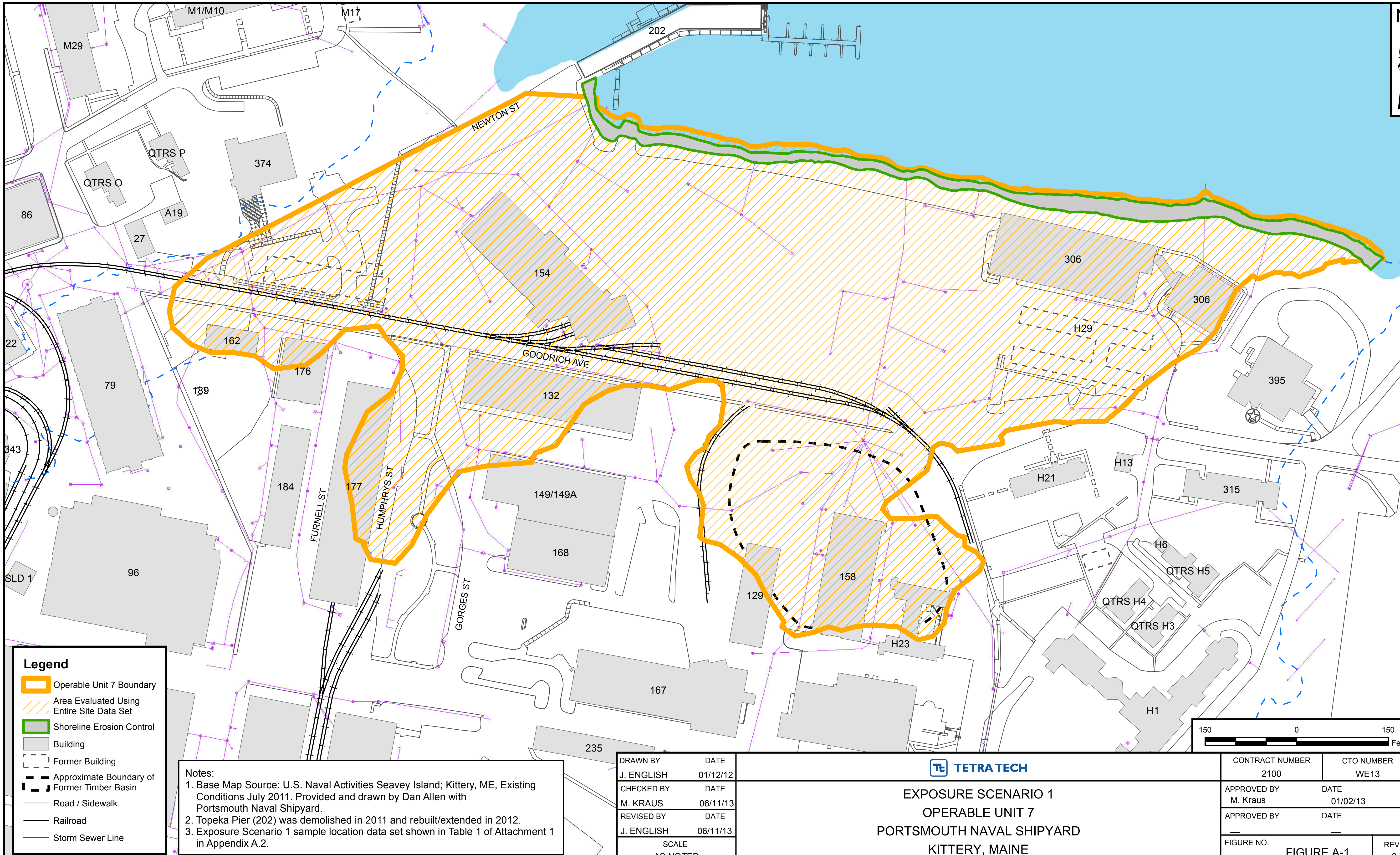

Legend

- Operable Unit 7 Boundary
- Area Evaluated Using Entire Site Data Set
- Shoreline Erosion Control
- Building
- Former Building
- Approximate Boundary of Former Timber Basin
- Road / Sidewalk
- Railroad
- Storm Sewer Line

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.
3. Exposure Scenario 1 sample location data set shown in Table 1 of Attachment 1 in Appendix A.2.

DRAWN BY	DATE	TETRA TECH	CONTRACT NUMBER	CTO NUMBER
J. ENGLISH	01/12/12		2100	WE13
CHECKED BY	DATE	EXPOSURE SCENARIO 1	APPROVED BY	DATE
M. KRAUS	06/11/13	OPERABLE UNIT 7	M. Kraus	01/02/13
REVISED BY	DATE	PORTSMOUTH NAVAL SHIPYARD	APPROVED BY	DATE
J. ENGLISH	06/11/13	KITTERY, MAINE	—	—
SCALE			FIGURE NO.	REV
AS NOTED			FIGURE A-1	0

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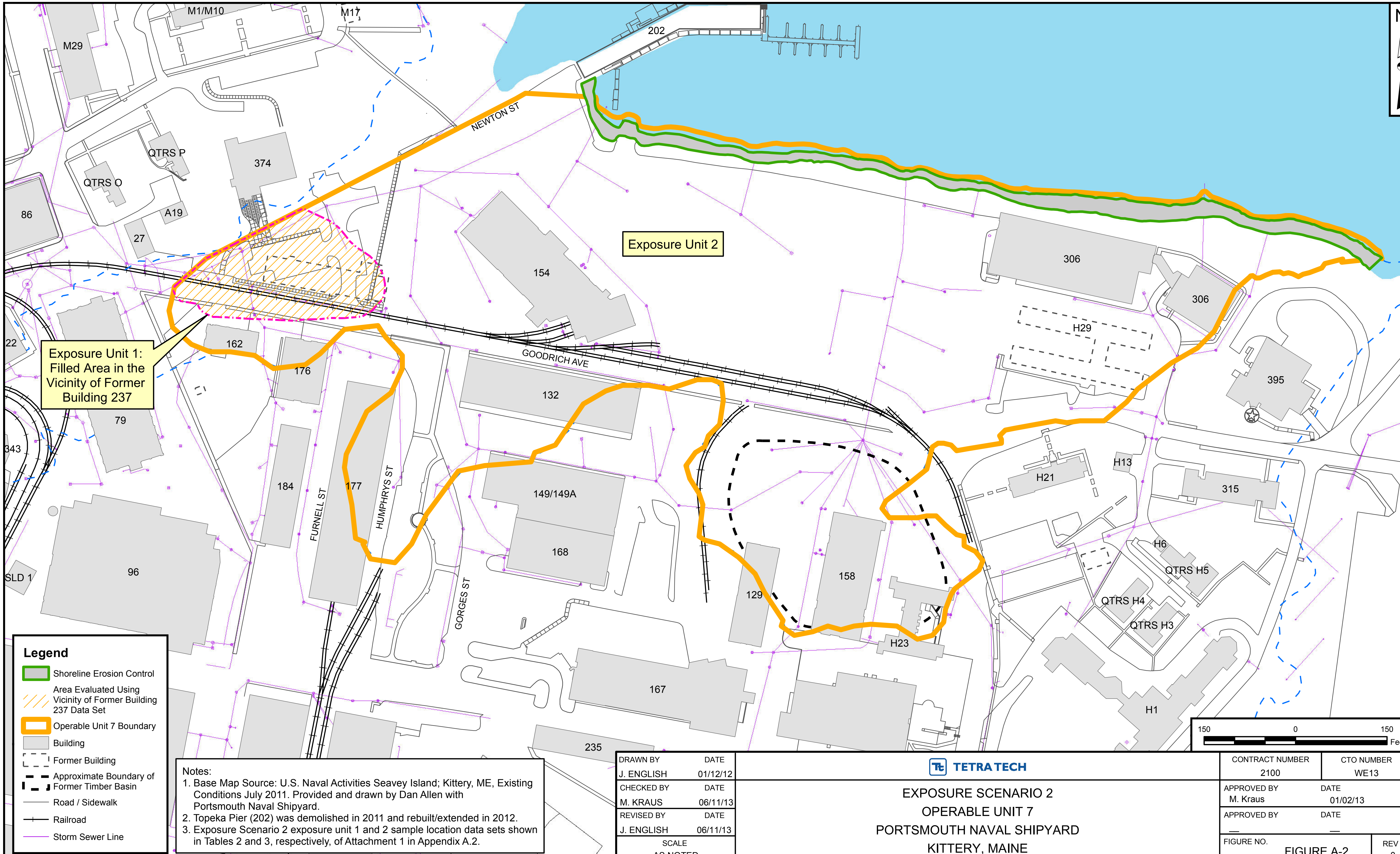

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.
3. Exposure Scenario 2 exposure unit 1 and 2 sample location data sets shown in Tables 2 and 3, respectively, of Attachment 1 in Appendix A.2.

DRAWN BY J. ENGLISH	DATE 01/12/12
CHECKED BY M. KRAUS	DATE 06/11/13
REVISED BY J. ENGLISH	DATE 06/11/13
SCALE AS NOTED	

TETRA TECH

EXPOSURE SCENARIO 2
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER 2100	CTO NUMBER WE13
APPROVED BY M. Kraus	DATE 01/02/13
APPROVED BY —	DATE —
FIGURE NO. FIGURE A-2	REV 0

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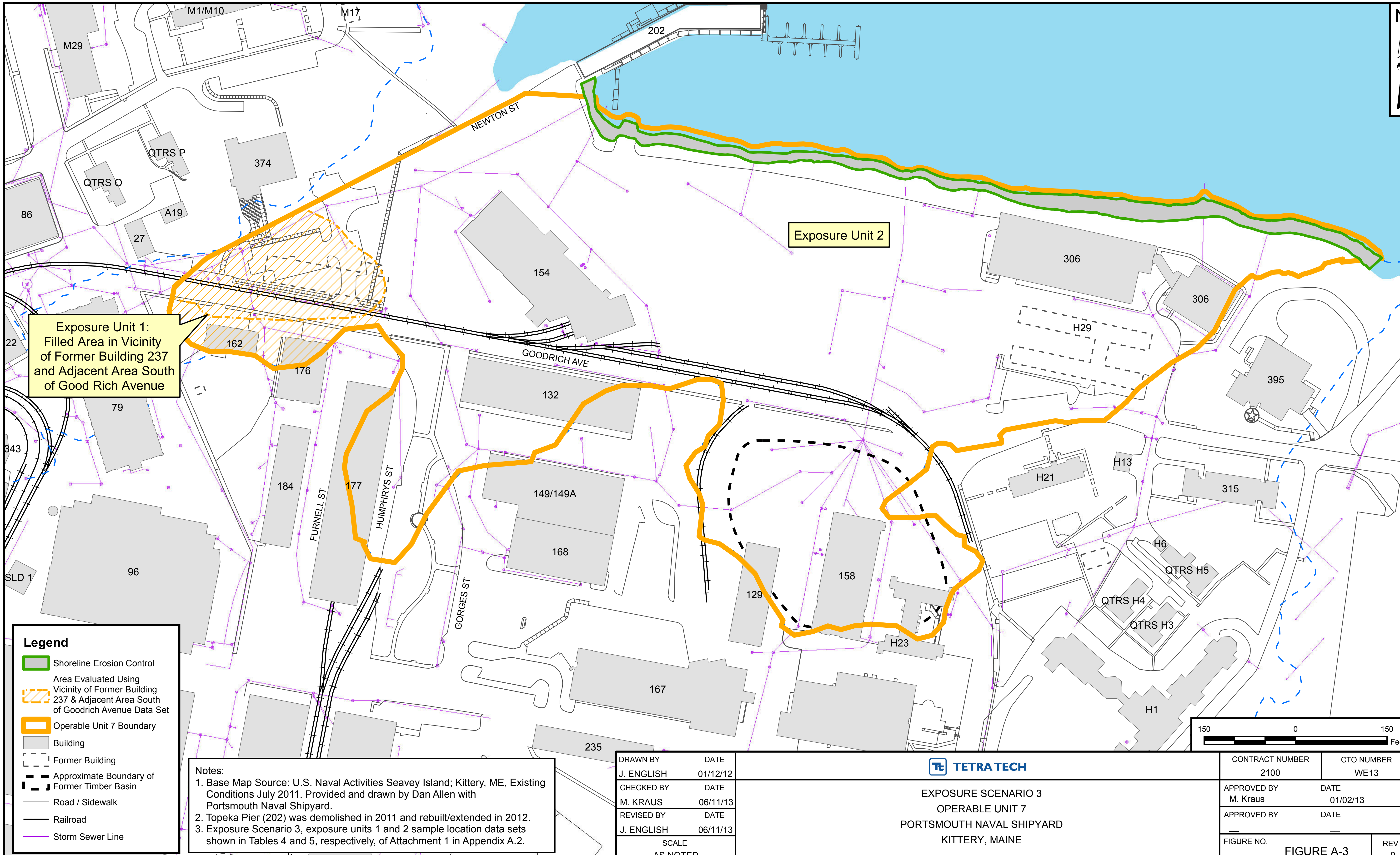

Notes:
1. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
2. Topeka Pier (202) was demolished in 2011 and rebuilt/extended in 2012.
3. Exposure Scenario 3, exposure units 1 and 2 sample location data sets shown in Tables 4 and 5, respectively, of Attachment 1 in Appendix A.2.

DRAWN BY	DATE
J. ENGLISH	01/12/12
CHECKED BY	DATE
M. KRAUS	06/11/13
REVISED BY	DATE
J. ENGLISH	06/11/13
SCALE	
AS NOTED	

TETRA TECH

EXPOSURE SCENARIO 3
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13

APPROVED BY	DATE
M. Kraus	01/02/13
APPROVED BY	DATE
—	—

FIGURE NO.	REV
FIGURE A-3	0

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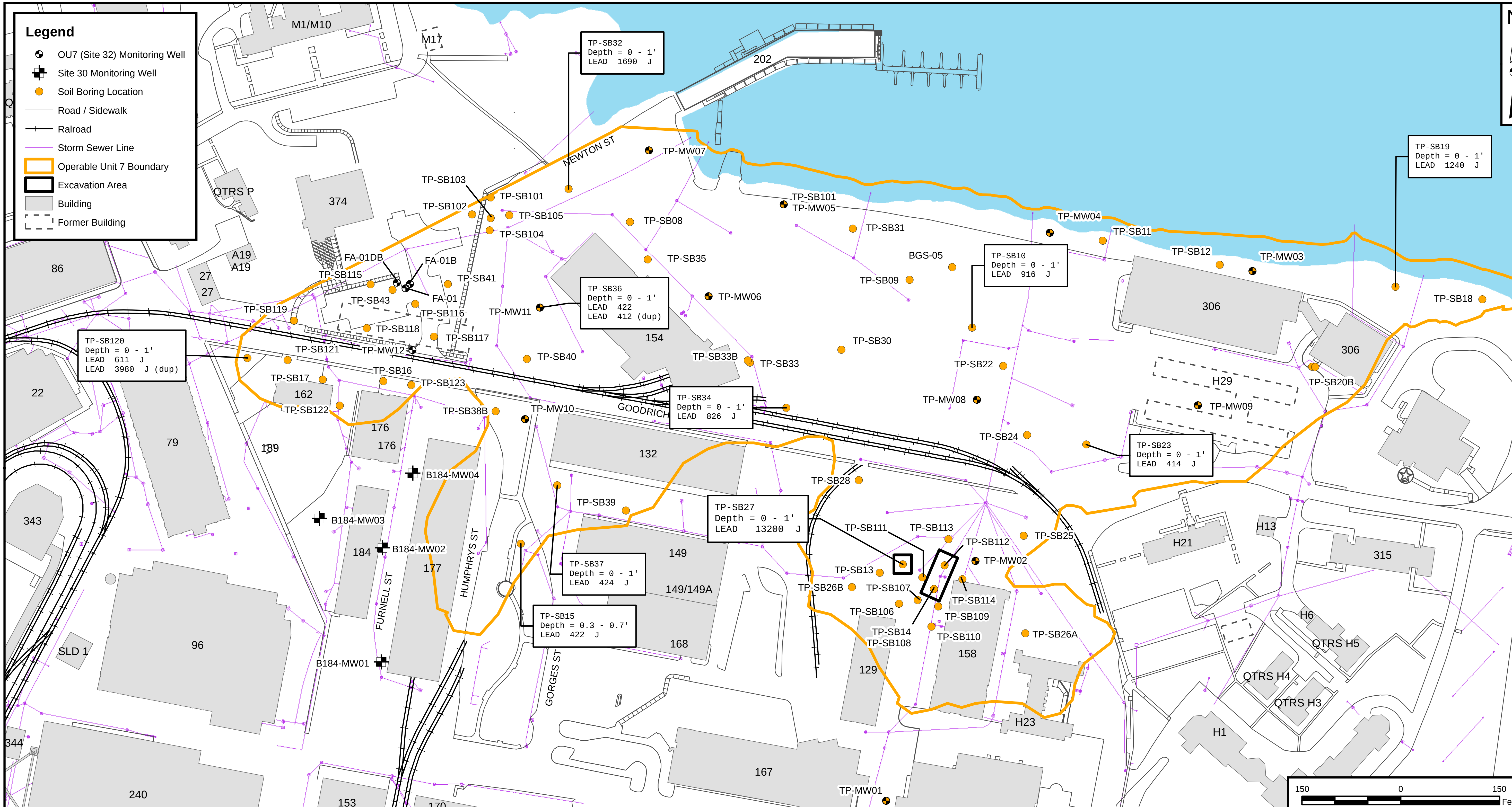

Notes:
1. All results shown in mg/kg.
2. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.

PRG = Preliminary Remediation Goal
DUP = Duplicate Sample

Residential PRG (mg/kg)
Lead: 400

DRAWN BY	DATE
J. ENGLISH	01/19/12
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M. KRAUS	02/21/13
REVISED BY	DATE
J. ENGLISH	02/21/13
SCALE	
AS NOTED	

TETRA TECH

SURFACE SOIL PRG EXCEEDANCES - RESIDENTIAL
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/02/13
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE A-4	0

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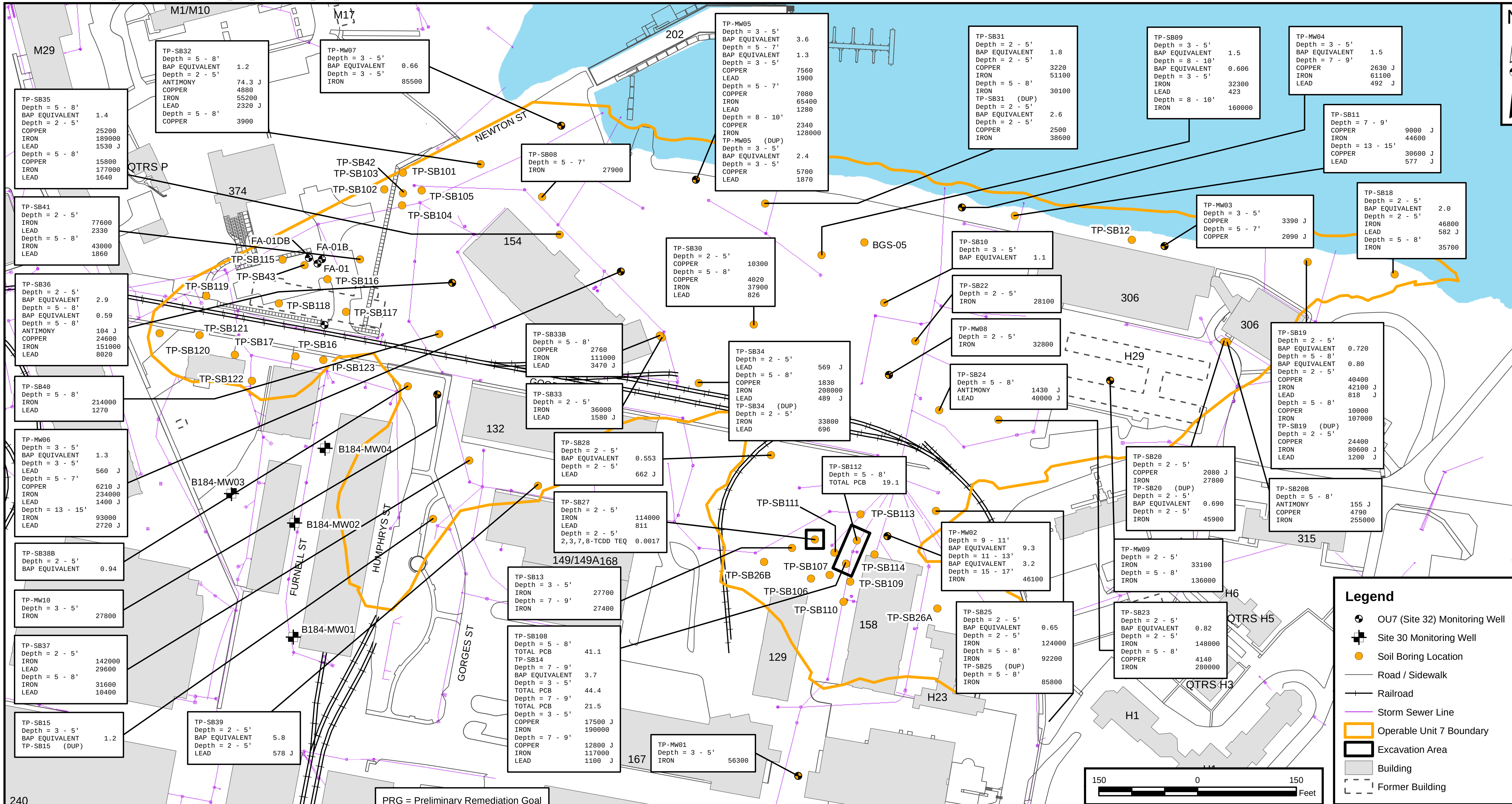

Notes:
1. All results shown in mg/kg.
2. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
3. BAP equivalents calculated using one-half the detection limit for non-detects.
4. Total PCBs calculated using one-half the detection limit for non-detects.
5. 2,3,7,8-TCDD TEQ calculated using World Health Organization (WHO) 2005 toxcity equivalency factors and one-half the detection limit for non-detects.

PRG = Preliminary Remediation Goal
DUP = Duplicate Sample

Residential PRG (mg/kg)
Total PCBs: 7.3
2,3,7,8-TCDD TEQ: 0.000051
BAP equivalents: 0.5
Antimony: 31
Copper: 1500
Iron: 27,000
Lead: 400

DRAWN BY	DATE
J. ENGLISH	01/13/12
CHECKED BY	DATE
M. KRAUS	02/21/13
REVISED BY	DATE
J. ENGLISH	02/21/13
SCALE	
AS NOTED	

TETRA TECH

SUBSURFACE SOIL PRG EXCEEDANCES - RESIDENTIAL
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY M. Kraus	DATE 01/02/13
APPROVED BY	DATE
FIGURE NO. FIGURE A-5	REV 0

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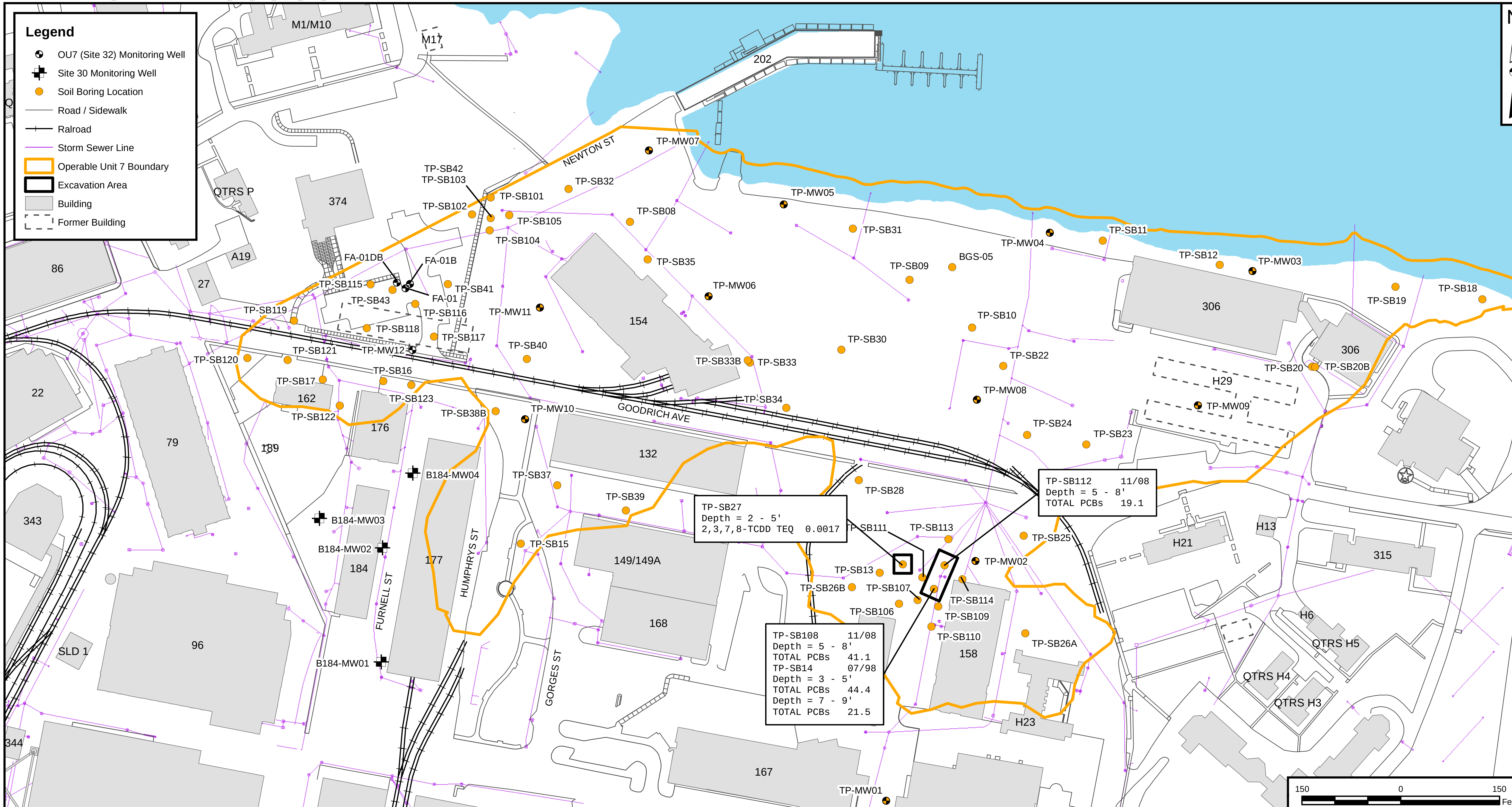

Notes:
1. All results shown in mg/kg.
2. Base Map Source: U.S. Naval Activities Seavey Island; Kittery, ME, Existing Conditions July 2011. Provided and drawn by Dan Allen with Portsmouth Naval Shipyard.
3. Total PCBs calculated using one-half the detection limit for non-detects.
4. 2, 3, 7, 8-TCDD TEQ calculated using World Health Organization (WHO) 2005 toxicity equivalency factors and one-half the detection limit for non-detects.

PRG = Preliminary Remediation Goal
PCB = Polychlorinated Biphenyl

Industrial PRG (mg/kg)
Total PCBs: 7.4
2,3,7,8-TCDD TEQ: 0.0006

DRAWN BY	DATE
J. ENGLISH	01/20/12
CHECKED BY	DATE
M. KRAUS	02/21/13
REVISED BY	DATE
J. ENGLISH	02/21/13
SCALE	
AS NOTED	

TETRA TECH

SUBSURFACE SOIL PRG EXCEEDANCES - INDUSTRIAL
OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD
KITTERY, MAINE

CONTRACT NUMBER	CTO NUMBER
2100	WE13
APPROVED BY	DATE
M. Kraus	01/02/13
APPROVED BY	DATE
—	—
FIGURE NO.	REV
FIGURE A-6	0

ATTACHMENT 1

EXPOSURE SCENARIO DATASETS AND EPC CALCULATIONS

TABLE 1

SAMPLE LIST FOR EXPOSURE SCENARIO 1
OPERABLE UNIT 7 FEASIBILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Surface Soil

Sample Identifier		
BGS-05	TPSS1080001	TPSS230001
TP-SS01-0001-98	TPSS1090001	TPSS240001
TP-SS02-0001-98	TPSS1100001	TPSS250001
TP-SS03-0001-98	TPSS1110001	TPSS26A0001
TP-SS04-0001-98	TPSS1120001	TPSS26B0001
TP-SS05-0001-98	TPSS1130001	TPSS270001
TP-SS06-0001-98	TPSS1140001	TPSS280001
TP-SS07-0001-98	TPSS1150001	TPSS290001
TP-SS08-0001-98	TPSS1160001	TPSS300001
TP-SS09-0001-98	TPSS1160001-D	TPSS310001
TP-SS09-0001-98-D	TPSS1170001	TPSS320001
TP-SS10-0001-98	TPSS1170001-D	TPSS33B0001
TP-SS11-0001-98	TPSS1180001	TPSS340001
TP-SS11-0001-98-D	TPSS1190001	TPSS350001
TP-SS12-0001-98	TPSS1200001	TPSS360001
TP-SS15-0001-98	TPSS1200001-D	TPSS360001-D
TP-SS17-0001-98	TPSS1210001	TPSS370001
TPSS1010001	TPSS1220001	TPSS38B0001
TPSS1020001	TPSS1230001	TPSS390001
TPSS1030001	TPSS180001	TPSS400001
TPSS1040001	TPSS190001	TPSS410001
TPSS1050001	TPSS200001	TPSS420001
TPSS1060001	TPSS210001	TPSS420001-D
TPSS1070001	TPSS220001	TPSS430001

Subsurface Soil

Sample Identifier		
TP-SB01-0305-98	TPSB1080205	TPSB230205
TP-SB01-0810-98	TPSB1080508	TPSB230508
TP-SB02-0305-98	TPSB1090205	TPSB240205
TP-SB03-0305-98	TPSB1090508	TPSB240508
TP-SB03-0507-98	TP-SB11-0305-98	TPSB250205
TP-SB04-0305-98	TP-SB11-0709-98	TPSB250508
TP-SB04-0709-98	TPSB1100205	TPSB250508-D
TP-SB05-0305-98	TPSB1100508	TPSB26A0203
TP-SB05-0305-98-D	TPSB1110205	TPSB26B0205
TP-SB05-0507-98	TPSB1110508	TPSB26B0508
TP-SB05-0810-98	TPSB1120205	TPSB270205
TP-SB06-0305-98	TPSB1120508	TPSB270508
TP-SB06-0507-98	TPSB1130205	TPSB270508-D
TP-SB07-0305-98	TPSB1130508	TPSB280205
TP-SB07-0709-98	TPSB1140205	TPSB280508
TPSB290205	TPSB1140508	TPSB300205
TPSB290508	TPSB1170205	TPSB300508
TPSB210205	TPSB1170205-D	TPSB310205
TPSB210508	TPSB1180205	TPSB310205-D
TP-SB08-0305-98	TPSB1180205-D	TPSB310508
TP-SB08-0507-98	TP-SB12-0507-98	TPSB320205
TP-SB09-0305-98	TP-SB13-0305-98	TPSB320508
TP-SB09-0507-98	TP-SB13-0709-98	TPSB330205
TP-SB09-0810-98	TP-SB14-0305-98	TPSB33B0205
TP-SB10-0305-98	TP-SB14-0709-98	TPSB33B0508
TP-SB10-0709-98	TP-SB15-0305-98	TPSB38A0305
TPSB1010205	TP-SB15-0709-98	TPSB38A0709
TPSB1010508	TP-SB16-0305-98	TPSB340205
TPSB1020205	TP-SB17-0305-98	TPSB340205-D
TPSB1020205-D	TP-SB17-0709-98	TPSB340508
TPSB1020508	TPSB180205	TPSB350205
TPSB1030205	TPSB180508	TPSB350508
TPSB1030508	TPSB190205	TPSB360205
TPSB1030508-D	TPSB190205-D	TPSB360508
TPSB1040205	TPSB190508	TPSB370205
TPSB1040508	TPSB200205	TPSB370508
TPSB1050205	TPSB200205-D	TPSB38B0205
TPSB1050508	TPSB200506	TPSB390205
TPSB1060205	TPSB20B0203	TPSB400205
TPSB1060508	TPSB20B0508	TPSB400508
TPSB1070205	TPSB220205	TPSB410205
TPSB1070508	TPSB220508	TPSB410508

TABLE 2

SAMPLE LIST FOR EXPOSURE SCENARIO 2 - EXPOSURE UNIT 1
OPERABLE UNIT 7 FEASIBILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Surface Soil

Sample Identifier
TPSS1150001
TPSS1160001
TPSS1160001D
TPSS1170001
TPSS1170001D
TPSS1180001
TPSS1190001
TPSS1210001
TPSS430001

Subsurface Soil

Sample Identifier
TP-SB16-0305-98
TP-SB16-1719-98
TPSB1170205
TPSB1170205-D
TPSB1180205
TPSB1180205-D

TABLE 3

SAMPLE LIST FOR SCENARIO 2 - EXPOSURE UNIT 2[(1)]
OPERABLE UNIT 7 FEASIBILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Surface Soil

Sample Identifier		
BGS-05	TPSS1080001	TPSS240001
TP-SS01-0001-98	TPSS1090001	TPSS250001
TP-SS02-0001-98	TP-SS11-0001-98	TPSS26A0001
TP-SS03-0001-98	TP-SS11-0001-98-D	TPSS26B0001
TP-SS04-0001-98	TPSS1100001	TPSS270001
TP-SS05-0001-98	TPSS1110001	TPSS280001
TP-SS06-0001-98	TPSS1120001	TPSS300001
TP-SS07-0001-98	TPSS1130001	TPSS310001
TPSS290001	TPSS1140001	TPSS320001
TPSS210001	TP-SS12-0001-98	TPSS33B0001
TP-SS08-0001-98	TPSS1200001	TPSS340001
TP-SS09-0001-98	TPSS1200001-D	TPSS350001
TP-SS09-0001-98-D	TPSS1220001	TPSS360001
TP-SS10-0001-98	TPSS1230001	TPSS360001-D
TPSS1010001	TP-SS15-0001-98	TPSS370001
TPSS1020001	TP-SS17-0001-98	TPSS38B0001
TPSS1030001	TPSS180001	TPSS390001
TPSS1040001	TPSS190001	TPSS400001
TPSS1050001	TPSS200001	TPSS410001
TPSS1060001	TPSS220001	TPSS420001
TPSS1070001	TPSS230001	TPSS420001-D

Subsurface Soil

Sample Identifier		
TP-SB01-0305-98	TPSB1090508	TPSB250508
TP-SB01-0810-98	TPSB1100205	TPSB250508-D
TP-SB02-0305-98	TPSB1100508	TPSB26A0203
TP-SB03-0305-98	TP-SB11-0305-98	TPSB26B0205
TP-SB03-0507-98	TP-SB11-0709-98	TPSB26B0508
TP-SB04-0305-98	TPSB1110205	TPSB270205
TP-SB04-0709-98	TPSB1110508	TPSB270508
TP-SB05-0305-98	TPSB1120205	TPSB270508-D
TP-SB05-0305-98-D	TPSB1120508	TPSB280205
TP-SB05-0507-98	TPSB1130205	TPSB280508
TP-SB05-0810-98	TPSB1130508	TPSB290205
TP-SB06-0305-98	TPSB1140205	TPSB290508
TP-SB06-0507-98	TPSB1140508	TPSB300205
TP-SB07-0305-98	TP-SB12-0507-98	TPSB300508
TP-SB07-0709-98	TP-SB13-0305-98	TPSB310205
TP-SB08-0305-98	TP-SB13-0709-98	TPSB310205-D
TP-SB08-0507-98	TP-SB14-0305-98	TPSB310508
TP-SB09-0305-98	TP-SB14-0709-98	TPSB320205
TP-SB09-0507-98	TP-SB15-0305-98	TPSB320508
TP-SB09-0810-98	TP-SB15-0709-98	TPSB330205
TP-SB10-0305-98	TP-SB17-0305-98	TPSB33B0205
TP-SB10-0709-98	TP-SB17-0709-98	TPSB33B0508
TPSB1010205	TPSB180205	TPSB340205
TPSB1010508	TPSB180508	TPSB340205-D
TPSB1020205	TPSB190205	TPSB340508
TPSB1020205-D	TPSB190205-D	TPSB350205
TPSB1020508	TPSB190508	TPSB350508
TPSB1030205	TPSB200205	TPSB360205
TPSB1030508	TPSB200205-D	TPSB360508
TPSB1030508-D	TPSB200506	TPSB370205
TPSB1040205	TPSB20B0203	TPSB370508
TPSB1040508	TPSB20B0508	TPSB38A0305
TPSB1050205	TPSB210205	TPSB38A0709
TPSB1050508	TPSB210508	TPSB38B0205
TPSB1060205	TPSB220205	TPSB390205
TPSB1060508	TPSB220508	TPSB400205
TPSB1070205	TPSB230205	TPSB400508
TPSB1070508	TPSB230508	TPSB410205
TPSB1080205	TPSB240205	TPSB410508
TPSB1080508	TPSB240508	
TPSB1090205	TPSB250205	

1 - Excludes samples collected from the filled area in the vicinity of former Building 237.

TABLE 4

SAMPLE LIST FOR SCENARIO 3 - EXPOSURE UNIT 1
OPERABLE UNIT 7 FEASIBILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Surface Soil

Sample Identifier
TPSS1150001
TPSS1160001
TPSS1160001-D
TPSS1170001
TPSS1170001-D
TPSS1180001
TPSS1190001
TPSS1200001
TPSS1200001-D
TPSS1210001
TPSS1220001
TPSS1230001
TP-SS17-0001-98
TPSS430001

Subsurface Soil

Sample Identifier
TPSB1170205
TPSB1170205-D
TPSB1180205
TPSB1180205-D
TP-SB16-0305-98
TP-SB17-0305-98
TP-SB17-0709-98

TABLE 5

SAMPLE LIST FOR SCENARIO 3 - EXPOSURE UNIT 2[1]
OPERABLE UNIT 7 FEASIBILITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Surface Soil

Sample Identifier		
BGS-05	TPSS1070001	TPSS26A0001
TP-SS01-0001-98	TPSS1080001	TPSS26B0001
TP-SS02-0001-98	TPSS1090001	TPSS270001
TP-SS03-0001-98	TP-SS11-0001-98	TPSS280001
TP-SS04-0001-98	TP-SS11-0001-98-D	TPSS300001
TP-SS05-0001-98	TPSS1100001	TPSS310001
TP-SS06-0001-98	TPSS1110001	TPSS320001
TP-SS07-0001-98	TPSS1120001	TPSS33B0001
TPSS290001	TPSS1130001	TPSS340001
TPSS210001	TPSS1140001	TPSS350001
TP-SS08-0001-98	TP-SS12-0001-98	TPSS360001
TP-SS09-0001-98	TP-SS15-0001-98	TPSS360001-D
TP-SS09-0001-98-D	TPSS180001	TPSS370001
TP-SS10-0001-98	TPSS190001	TPSS38B0001
TPSS1010001	TPSS200001	TPSS390001
TPSS1020001	TPSS220001	TPSS400001
TPSS1030001	TPSS230001	TPSS410001
TPSS1040001	TPSS240001	TPSS420001
TPSS1050001	TPSS250001	TPSS420001-D
TPSS1060001		

Subsurface Soil

Sample Identifier		
TPSB290205	TPSB190508	TPSB370205
TPSB290508	TPSB200205	TPSB370508
TPSB210205	TPSB200205-D	TPSB38B0205
TPSB210508	TPSB200506	TPSB390205
TPSB38A0305	TPSB20B0203	TPSB400205
TPSB38A0709	TPSB20B0508	TPSB400508
TPSB1010205	TPSB220205	TPSB410205
TPSB1010508	TPSB220508	TPSB410508
TPSB1020205	TPSB230205	TP-SB01-0305-98
TPSB1020205-D	TPSB230508	TP-SB01-0810-98
TPSB1020508	TPSB240205	TP-SB02-0305-98
TPSB1030205	TPSB240508	TP-SB03-0305-98
TPSB1030508	TPSB250205	TP-SB03-0507-98
TPSB1030508-D	TPSB250508	TP-SB04-0305-98
TPSB1040205	TPSB250508-D	TP-SB04-0709-98
TPSB1040508	TPSB26A0203	TP-SB05-0305-98
TPSB1050205	TPSB26B0205	TP-SB05-0305-98-D
TPSB1050508	TPSB26B0508	TP-SB05-0507-98
TPSB1060205	TPSB270205	TP-SB05-0810-98
TPSB1060508	TPSB270508	TP-SB06-0305-98
TPSB1070205	TPSB270508-D	TP-SB06-0507-98
TPSB1070508	TPSB280205	TP-SB07-0305-98
TPSB1080205	TPSB280508	TP-SB07-0709-98
TPSB1080508	TPSB300205	TP-SB08-0305-98
TPSB1090205	TPSB300508	TP-SB08-0507-98
TPSB1090508	TPSB310205	TP-SB09-0305-98
TPSB1100205	TPSB310205-D	TP-SB09-0507-98
TPSB1100508	TPSB310508	TP-SB09-0810-98
TPSB1110205	TPSB320205	TP-SB10-0305-98
TPSB1110508	TPSB320508	TP-SB10-0709-98
TPSB1120205	TPSB330205	TP-SB11-0305-98
TPSB1120508	TPSB33B0205	TP-SB11-0709-98
TPSB1130205	TPSB33B0508	TP-SB12-0507-98
TPSB1130508	TPSB340205	TP-SB13-0305-98
TPSB1140205	TPSB340205-D	TP-SB13-0709-98
TPSB1140508	TPSB340508	TP-SB14-0305-98
TPSB180205	TPSB350205	TP-SB14-0709-98
TPSB180508	TPSB350508	TP-SB15-0305-98
TPSB190205	TPSB360205	TP-SB15-0709-98
TPSB190205-D	TPSB360508	

1 - Excludes samples collected from the filled area in the vicinity of former Building 237 and the area south of Goodrich Avenue.

EPCs for Exposure Scenario 2, Exposure Unit 2

Remainder of Site Excluding the Filled Area in the Vincinity of Former Building 237

Surface Soil EPCs

for

Exposure Scenario 2: Exposure Unit 2

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	Converted_Data_2.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

LEAD

General Statistics

Number of Valid Data	44	Number of Detected Data	43
Number of Distinct Detected Data	43	Number of Non-Detect Data	1
Number of Missing Values	14	Percent Non-Detects	2.27%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	6.1	Minimum Detected	1.808
Maximum Detected	13200	Maximum Detected	9.488
Mean of Detected	595.5	Mean of Detected	4.893
SD of Detected	2022	SD of Detected	1.577
Minimum Non-Detect	21.2	Minimum Non-Detect	3.054
Maximum Non-Detect	21.2	Maximum Non-Detect	3.054

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.288	Shapiro Wilk Test Statistic	0.98
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	582.2	Mean	4.835
SD	2000	SD	1.605
95% DL/2 (t) UCL	1089	95% H-Stat (DL/2) UCL	979.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	321.6	Mean in Log Scale	4.838
SD	2196	SD in Log Scale	1.6
95% MLE (t) UCL	878.1	Mean in Original Scale	582.2
95% MLE (Tiku) UCL	849.6	SD in Original Scale	2000
		95% t UCL	1089
		95% Percentile Bootstrap UCL	1168
		95% BCA Bootstrap UCL	1533
		95% H UCL	971.5
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.419	**Data appear Lognormal at 5% Significance Level**	
Theta Star	1421		
nu star	36.05		
A-D Test Statistic	2.93	**Nonparametric Statistics**	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.829	Mean	582.2
5% K-S Critical Value	0.144	SD	1977
Data not Gamma Distributed at 5% Significance Level		SE of Mean	301.6
		95% KM (t) UCL	1089
Assuming Gamma Distribution		95% KM (z) UCL	1078
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1089
Minimum	0.000001	95% KM (bootstrap t) UCL	3035
Maximum	13200	95% KM (BCA) UCL	1189
Mean	582	95% KM (Percentile Bootstrap) UCL	1161
Median	103.5	95% KM (Chebyshev) UCL	1897
SD	2000	97.5% KM (Chebyshev) UCL	2466
k star	0.345	99% KM (Chebyshev) UCL	3583
Theta star	1689		
Nu star	30.32	**Potential UCLs to Use**	
AppChi2	18.75	97.5% KM (Chebyshev) UCL	2466
95% Gamma Approximate UCL (Use when n >= 40)	941.3		
95% Adjusted Gamma UCL (Use when n < 40)	957.1		
Note: DL/2 is not a recommended method.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Subsurface Soil EPCs

for

Exposure Scenario 2: Exposure Unit 2

	General UCL Statistics for Full Data Sets		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

TEQ WHO-2005-HALFND

General Statistics			
Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	64		
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.876	Minimum of Log Data	-0.132
Maximum	1684	Maximum of Log Data	7.429
Mean	135.3	Mean of log Data	1.796
Geometric Mean	6.027	SD of log Data	1.921
Median	3.559		
SD	465.4		
Std. Error of Mean	129.1		
Coefficient of Variation	3.44		
Skewness	3.603		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.322	Shapiro Wilk Test Statistic	0.734
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	365.4	95% H-UCL	492.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	100.6
95% Adjusted-CLT UCL (Chen-1995)	485.5	97.5% Chebyshev (MVUE) UCL	132
95% Modified-t UCL (Johnson-1978)	386.9	99% Chebyshev (MVUE) UCL	193.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.229	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	590.5		
MLE of Mean	135.3		
MLE of Standard Deviation	282.7		
nu star	5.957		
Approximate Chi Square Value (.05)	1.618	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	347.6
Adjusted Chi Square Value	1.318	95% Jackknife UCL	365.4
		95% Standard Bootstrap UCL	336.7
Anderson-Darling Test Statistic	3.038	95% Bootstrap-t UCL	31402
Anderson-Darling 5% Critical Value	0.856	95% Hall's Bootstrap UCL	10590
Kolmogorov-Smirnov Test Statistic	0.446	95% Percentile Bootstrap UCL	392.2
Kolmogorov-Smirnov 5% Critical Value	0.26	95% BCA Bootstrap UCL	522.9
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	698
		97.5% Chebyshev(Mean, Sd) UCL	941.4

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1420
95% Approximate Gamma UCL (Use when n >= 40)	498.2		
95% Adjusted Gamma UCL (Use when n < 40)	611.3		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	1420

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper

General Statistics

Number of Valid Observations	76	Number of Distinct Observations	73
Number of Missing Values	37		
Raw Statistics		**Log-transformed Statistics**	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	32400	Maximum of Log Data	10.39
Mean	3077	Mean of log Data	6.194
Geometric Mean	490	SD of log Data	2.093
Median	356		
SD	6182		
Std. Error of Mean	709.2		
Coefficient of Variation	2.009		
Skewness	3.008		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.31	Lilliefors Test Statistic	0.126
Lilliefors Critical Value	0.102	Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4258	95% H-UCL	10307
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	10595
95% Adjusted-CLT UCL (Chen-1995)	4505	97.5% Chebyshev (MVUE) UCL	13441
95% Modified-t UCL (Johnson-1978)	4299	99% Chebyshev (MVUE) UCL	19032
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.358	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	8592		
MLE of Mean	3077		
MLE of Standard Deviation	5141		
nu star	54.43		
Approximate Chi Square Value (.05)	38.48	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	4243
Adjusted Chi Square Value	38.22	95% Jackknife UCL	4258
		95% Standard Bootstrap UCL	4238
Anderson-Darling Test Statistic	3.11	95% Bootstrap-t UCL	4613
Anderson-Darling 5% Critical Value	0.85	95% Hall's Bootstrap UCL	4594
Kolmogorov-Smirnov Test Statistic	0.185	95% Percentile Bootstrap UCL	4326

Kolmogorov-Smirnov 5% Critical Value	0.11	95% BCA Bootstrap UCL	4569
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6168
		97.5% Chebyshev(Mean, Sd) UCL	7506
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10133
95% Approximate Gamma UCL (Use when n >= 40)	4352		
95% Adjusted Gamma UCL (Use when n < 40)	4382		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	6168

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	76	Number of Distinct Observations	75
Number of Missing Values	37		

Raw Statistics		**Log-transformed Statistics**	
Minimum	9280	Minimum of Log Data	9.136
Maximum	280000	Maximum of Log Data	12.54
Mean	65827	Mean of log Data	10.68
Geometric Mean	43618	SD of log Data	0.876
Median	31950		
SD	66108		
Std. Error of Mean	7583		
Coefficient of Variation	1.004		
Skewness	1.553		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.258	Lilliefors Test Statistic	0.163
Lilliefors Critical Value	0.102	Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	78456	95% H-UCL	79511
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	95645
95% Adjusted-CLT UCL (Chen-1995)	79743	97.5% Chebyshev (MVUE) UCL	109524
95% Modified-t UCL (Johnson-1978)	78681	99% Chebyshev (MVUE) UCL	136786
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.313	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	50149		
MLE of Mean	65827		
MLE of Standard Deviation	57456		
nu star	199.5		
Approximate Chi Square Value (.05)	167.8	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	78300
Adjusted Chi Square Value	167.3	95% Jackknife UCL	78456
		95% Standard Bootstrap UCL	78238

Anderson-Darling Test Statistic	4.212	95% Bootstrap-t UCL	80119
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	79640
Kolmogorov-Smirnov Test Statistic	0.206	95% Percentile Bootstrap UCL	78641
Kolmogorov-Smirnov 5% Critical Value	0.105	95% BCA Bootstrap UCL	78917
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	98881
		97.5% Chebyshev(Mean, Sd) UCL	113183
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	141278
95% Approximate Gamma UCL (Use when n >= 40)	78253		
95% Adjusted Gamma UCL (Use when n < 40)	78514		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	98881

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)

and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	58	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	31
Number of Missing Values	55	Percent Non-Detects	53.45%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.26	Minimum Detected	-1.347
Maximum Detected	1430	Maximum Detected	7.265
Mean of Detected	68.75	Mean of Detected	1.441
SD of Detected	274.5	SD of Detected	2.051
Minimum Non-Detect	0.14	Minimum Non-Detect	-1.966
Maximum Non-Detect	3.2	Maximum Non-Detect	1.163
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	45
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	77.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.265	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	32.23	Mean	0.0836
SD	188.5	SD	1.96
95% DL/2 (t) UCL	73.62	95% H-Stat (DL/2) UCL	19.68
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.987
		SD in Log Scale	2.729
		Mean in Original Scale	32.03
		SD in Original Scale	188.6
		95% t UCL	73.43
		95% Percentile Bootstrap UCL	79.97
		95% BCA Bootstrap UCL	112.6
		95% H-UCL	98.84
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.25	Data appear Lognormal at 5% Significance Level	
Theta Star	274.5		
nu star	13.53		

A-D Test Statistic	3.546	**Nonparametric Statistics**	
5% A-D Critical Value	0.873	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.873	Mean	32.18
5% K-S Critical Value	0.184	SD	186.9
Data not Gamma Distributed at 5% Significance Level		SE of Mean	25.01
		95% KM (t) UCL	73.99
Assuming Gamma Distribution		95% KM (z) UCL	73.31
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	73.53
Minimum	0.000001	95% KM (bootstrap t) UCL	419.4
Maximum	1430	95% KM (BCA) UCL	83.78
Mean	32	95% KM (Percentile Bootstrap) UCL	80.64
Median	0.000001	95% KM (Chebyshev) UCL	141.2
SD	188.6	97.5% KM (Chebyshev) UCL	188.4
k star	0.089	99% KM (Chebyshev) UCL	281
Theta star	359.5		
Nu star	10.33	**Potential UCLs to Use**	
AppChi2	4.146	99% KM (Chebyshev) UCL	281
95% Gamma Approximate UCL (Use when n >= 40)	79.7		
95% Adjusted Gamma UCL (Use when n < 40)	81.66		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Data	76	Number of Detected Data	73
Number of Distinct Detected Data	73	Number of Non-Detect Data	3
Number of Missing Values	37	Percent Non-Detects	3.95%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	18.2	Minimum Detected	2.901
Maximum Detected	40000	Maximum Detected	10.6
Mean of Detected	1700	Mean of Detected	5.747
SD of Detected	5878	SD of Detected	1.591
Minimum Non-Detect	4.3	Minimum Non-Detect	1.459
Maximum Non-Detect	23.4	Maximum Non-Detect	3.153
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	71
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	6.58%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.392	Lilliefors Test Statistic	0.0799
5% Lilliefors Critical Value	0.104	5% Lilliefors Critical Value	0.104
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1633	Mean	5.591
SD	5769	SD	1.748
95% DL/2 (t) UCL	2735	95% H-Stat (DL/2) UCL	2309
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1350	Mean in Log Scale	5.6
SD	5970	SD in Log Scale	1.723
95% MLE (t) UCL	2491	Mean in Original Scale	1633
95% MLE (Tiku) UCL	2380	SD in Original Scale	5769
		95% t UCL	2735
		95% Percentile Bootstrap UCL	2815
		95% BCA Bootstrap UCL	3466
		95% H UCL	2200
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.384	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4431		
nu star	56.02		
A-D Test Statistic	6.461	**Nonparametric Statistics**	
5% A-D Critical Value	0.844	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.844	Mean	1634
5% K-S Critical Value	0.112	SD	5731
Data not Gamma Distributed at 5% Significance Level		SE of Mean	661.9
		95% KM (t) UCL	2736
Assuming Gamma Distribution		95% KM (z) UCL	2723
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2736
Minimum	0.000001	95% KM (bootstrap t) UCL	5460
Maximum	40000	95% KM (BCA) UCL	2931
Mean	1633	95% KM (Percentile Bootstrap) UCL	2819
Median	257.5	95% KM (Chebyshev) UCL	4519
SD	5769	97.5% KM (Chebyshev) UCL	5768
k star	0.284	99% KM (Chebyshev) UCL	8220
Theta star	5747		
Nu star	43.19	**Potential UCLs to Use**	
AppChi2	29.12	97.5% KM (Chebyshev) UCL	5768
95% Gamma Approximate UCL (Use when n >= 40)	2422		
95% Adjusted Gamma UCL (Use when n < 40)	2441		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Total Aroclor HalfND

General Statistics

Number of Valid Data	86	Number of Detected Data	18
Number of Distinct Detected Data	18	Number of Non-Detect Data	68
Number of Missing Values	27	Percent Non-Detects	79.07%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	67.5	Minimum Detected	4.212
Maximum Detected	44400	Maximum Detected	10.7
Mean of Detected	7208	Mean of Detected	6.336
SD of Detected	14462	SD of Detected	2.307
Minimum Non-Detect	52.95	Minimum Non-Detect	3.969
Maximum Non-Detect	297	Maximum Non-Detect	5.694
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	78
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	8
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.70%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.558	Shapiro Wilk Test Statistic	0.792
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1550	Mean	4.349
SD	7100	SD	1.521
95% DL/2 (t) UCL	2823	95% H-Stat (DL/2) UCL	390.2
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.449
		SD in Log Scale	3.582
		Mean in Original Scale	1510
		SD in Original Scale	7108
		95% t UCL	2784
		95% Percentile Bootstrap UCL	2958
		95% BCA Bootstrap UCL	3469
		95% H-UCL	8112
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.266	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	27111		
nu star	9.572		
A-D Test Statistic	2.49	**Nonparametric Statistics**	
5% A-D Critical Value	0.853	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.853	Mean	1563
5% K-S Critical Value	0.222	SD	7055
Data not Gamma Distributed at 5% Significance Level		SE of Mean	782.9
		95% KM (t) UCL	2865
Assuming Gamma Distribution		95% KM (z) UCL	2851
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2832
Minimum	0.000001	95% KM (bootstrap t) UCL	4070
Maximum	44400	95% KM (BCA) UCL	3072
Mean	1509	95% KM (Percentile Bootstrap) UCL	2996
Median	0.000001	95% KM (Chebyshev) UCL	4975
SD	7108	97.5% KM (Chebyshev) UCL	6452
k star	0.0575	99% KM (Chebyshev) UCL	9352

Theta star	26222		
Nu star	9.896	Potential UCLs to Use	
AppChi2	3.877	97.5% KM (Chebyshev) UCL	6452
95% Gamma Approximate UCL (Use when n >= 40)	3851		
95% Adjusted Gamma UCL (Use when n < 40)	3916		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

BAP Equivalent-Half ND

General Statistics

Number of Valid Data	71	Number of Detected Data	58
Number of Distinct Detected Data	58	Number of Non-Detect Data	13
Number of Missing Values	42	Percent Non-Detects	18.31%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	72.32	Minimum Detected	4.281
Maximum Detected	5809	Maximum Detected	8.667
Mean of Detected	795.5	Mean of Detected	6.168
SD of Detected	1012	SD of Detected	0.974
Minimum Non-Detect	55	Minimum Non-Detect	4.007
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	41
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	30
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	57.75%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.259	Lilliefors Test Statistic	0.0931
5% Lilliefors Critical Value	0.116	5% Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	662.9	Mean	5.761
SD	956.3	SD	1.277
95% DL/2 (t) UCL	852.1	95% H-Stat (DL/2) UCL	1057
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	5.822
		SD in Log Scale	1.163
		Mean in Original Scale	664.7
		SD in Original Scale	955
		95% t UCL	853.6
		95% Percentile Bootstrap UCL	863.8
		95% BCA Bootstrap UCL	908.9
		95% H-UCL	929.8

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.069	**Data appear Lognormal at 5% Significance Level**	
Theta Star	743.9		
nu star	124.1		
A-D Test Statistic	1.925	**Nonparametric Statistics**	
5% A-D Critical Value	0.777	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.777	Mean	668.2
5% K-S Critical Value	0.12	SD	946.3
Data not Gamma Distributed at 5% Significance Level		SE of Mean	113.3
		95% KM (t) UCL	857.1
Assuming Gamma Distribution		95% KM (z) UCL	854.6
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	856.3
Minimum	0.000001	95% KM (bootstrap t) UCL	939
Maximum	5809	95% KM (BCA) UCL	852.1
Mean	649.9	95% KM (Percentile Bootstrap) UCL	872.7
Median	317.4	95% KM (Chebyshev) UCL	1162
SD	964.5	97.5% KM (Chebyshev) UCL	1376
k star	0.189	99% KM (Chebyshev) UCL	1796
Theta star	3441		
Nu star	26.81	**Potential UCLs to Use**	
AppChi2	16.01	95% KM (BCA) UCL	852.1
95% Gamma Approximate UCL (Use when n >= 40)	1089		
95% Adjusted Gamma UCL (Use when n < 40)	1100		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

<u>EPCs for Exposure Scenario 3, Exposure Unit 2</u>

Remainder of Site Excluding the Filled Area in the Vincinity of Former Building and the Adjacent Area South of Goodrich Avenue

Surface Soil EPCs

For

Exposure Scenario 3: Exposure Unit 2

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Data	40	Number of Detected Data	39
Number of Distinct Detected Data	39	Number of Non-Detect Data	1
Number of Missing Values	15	Percent Non-Detects	2.50%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	6.1	Minimum Detected	1.808
Maximum Detected	13200	Maximum Detected	9.488
Mean of Detected	591.1	Mean of Detected	4.857
SD of Detected	2102	SD of Detected	1.584
Minimum Non-Detect	21.2	Minimum Non-Detect	3.054
Maximum Non-Detect	21.2	Maximum Non-Detect	3.054

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.268	Shapiro Wilk Test Statistic	0.977
5% Shapiro Wilk Critical Value	0.939	5% Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	576.6	Mean	4.795
SD	2077	SD	1.612
95% DL/2 (t) UCL	1130	95% H-Stat (DL/2) UCL	1015
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	272	Mean in Log Scale	4.799
SD	2303	SD in Log Scale	1.606
95% MLE (t) UCL	885.6	Mean in Original Scale	576.6
95% MLE (Tiku) UCL	859.6	SD in Original Scale	2077
		95% t UCL	1130
		95% Percentile Bootstrap UCL	1204
		95% BCA Bootstrap UCL	1579
		95% H UCL	1003

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.411	**Data appear Lognormal at 5% Significance Level**	
Theta Star	1437		
nu star	32.08		
A-D Test Statistic	2.712	**Nonparametric Statistics**	
5% A-D Critical Value	0.829	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.829	Mean	576.6
5% K-S Critical Value	0.151	SD	2051
Data not Gamma Distributed at 5% Significance Level		SE of Mean	328.6
		95% KM (t) UCL	1130
Assuming Gamma Distribution		95% KM (z) UCL	1117
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1130
Minimum	0.000001	95% KM (bootstrap t) UCL	3770
Maximum	13200	95% KM (BCA) UCL	1250
Mean	576.3	95% KM (Percentile Bootstrap) UCL	1214
Median	114.6	95% KM (Chebyshev) UCL	2009
SD	2077	97.5% KM (Chebyshev) UCL	2628
k star	0.334	99% KM (Chebyshev) UCL	3846
Theta star	1725		
Nu star	26.72	**Potential UCLs to Use**	
AppChi2	15.94	97.5% KM (Chebyshev) UCL	2628
95% Gamma Approximate UCL (Use when n >= 40)	966.3		
95% Adjusted Gamma UCL (Use when n < 40)	985.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Subsurface Soil EPCs

For

Exposure Scenario 3: Exposure Unit 2

	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	WorkSheet.wst		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		
Total Aroclor Half ND			
	General Statistics		
Number of Valid Data	84	Number of Detected Data	18
Number of Distinct Detected Data	18	Number of Non-Detect Data	66
Number of Missing Values	27	Percent Non-Detects	78.57%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	67.5	Minimum Detected	4.212
Maximum Detected	44400	Maximum Detected	10.7
Mean of Detected	7208	Mean of Detected	6.336
SD of Detected	14462	SD of Detected	2.307
Minimum Non-Detect	52.95	Minimum Non-Detect	3.969
Maximum Non-Detect	297	Maximum Non-Detect	5.694
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	76
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	8
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.48%
	UCL Statistics		
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.558	Shapiro Wilk Test Statistic	0.792
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1584	Mean	4.345
SD	7181	SD	1.539
95% DL/2 (t) UCL	2888	95% H-Stat (DL/2) UCL	405.4
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.499
		SD in Log Scale	3.598
		Mean in Original Scale	1546
		SD in Original Scale	7189
		95% t UCL	2850
		95% Percentile Bootstrap UCL	2838
		95% BCA Bootstrap UCL	3511
		95% H-UCL	9409
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.266	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	27111		
nu star	9.572		

A-D Test Statistic	2.49	**Nonparametric Statistics**	
5% A-D Critical Value	0.853	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.853	Mean	1598
5% K-S Critical Value	0.222	SD	7135
Data not Gamma Distributed at 5% Significance Level		SE of Mean	801.1
		95% KM (t) UCL	2931
Assuming Gamma Distribution		95% KM (z) UCL	2916
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2898
Minimum	0.000001	95% KM (bootstrap t) UCL	4185
Maximum	44400	95% KM (BCA) UCL	3072
Mean	1545	95% KM (Percentile Bootstrap) UCL	2947
Median	0.000001	95% KM (Chebyshev) UCL	5090
SD	7190	97.5% KM (Chebyshev) UCL	6601
k star	0.0579	99% KM (Chebyshev) UCL	9569
Theta star	26684		
Nu star	9.725	**Potential UCLs to Use**	
AppChi2	3.771	97.5% KM (Chebyshev) UCL	6601
95% Gamma Approximate UCL (Use when n >= 40)	3984		
95% Adjusted Gamma UCL (Use when n < 40)	4053		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets
User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO-2005-Half ND

General Statistics			
Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	64		
Raw Statistics		**Log-transformed Statistics**	
Minimum	0.876	Minimum of Log Data	-0.132
Maximum	1684	Maximum of Log Data	7.429
Mean	135.3	Mean of log Data	1.796
Geometric Mean	6.027	SD of log Data	1.921
Median	3.559		
SD	465.4		
Std. Error of Mean	129.1		
Coefficient of Variation	3.44		
Skewness	3.603		
Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.322	Shapiro Wilk Test Statistic	0.734
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	365.4	95% H-UCL	492.2
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	100.6
95% Adjusted-CLT UCL (Chen-1995)	485.5	97.5% Chebyshev (MVUE) UCL	132
95% Modified-t UCL (Johnson-1978)	386.9	99% Chebyshev (MVUE) UCL	193.7
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.229	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	590.5		
MLE of Mean	135.3		
MLE of Standard Deviation	282.7		
nu star	5.957		
Approximate Chi Square Value (.05)	1.618	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	347.6
Adjusted Chi Square Value	1.318	95% Jackknife UCL	365.4
		95% Standard Bootstrap UCL	343.6
Anderson-Darling Test Statistic	3.038	95% Bootstrap-t UCL	30626
Anderson-Darling 5% Critical Value	0.856	95% Hall's Bootstrap UCL	9979
Kolmogorov-Smirnov Test Statistic	0.446	95% Percentile Bootstrap UCL	393.3
Kolmogorov-Smirnov 5% Critical Value	0.26	95% BCA Bootstrap UCL	525.3
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	698
		97.5% Chebyshev(Mean, Sd) UCL	941.4

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1420
95% Approximate Gamma UCL (Use when n >= 40)	498.2		
95% Adjusted Gamma UCL (Use when n < 40)	611.3		
Potential UCL to Use		Use 99% Chebyshev (Mean, Sd) UCL	1420

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper

General Statistics

Number of Valid Observations	74	Number of Distinct Observations	71
Number of Missing Values	37		
Raw Statistics		**Log-transformed Statistics**	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	32400	Maximum of Log Data	10.39
Mean	3158	Mean of log Data	6.255
Geometric Mean	520.6	SD of log Data	2.084
Median	381.8		
SD	6246		
Std. Error of Mean	726.1		
Coefficient of Variation	1.978		
Skewness	2.962		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.308	Lilliefors Test Statistic	0.124
Lilliefors Critical Value	0.103	Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4368	95% H-UCL	10800
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11087
95% Adjusted-CLT UCL (Chen-1995)	4620	97.5% Chebyshev (MVUE) UCL	14070
95% Modified-t UCL (Johnson-1978)	4410	99% Chebyshev (MVUE) UCL	19930
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.364	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	8683		
MLE of Mean	3158		
MLE of Standard Deviation	5237		
nu star	53.83		
Approximate Chi Square Value (.05)	37.97	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	4353
Adjusted Chi Square Value	37.71	95% Jackknife UCL	4368
		95% Standard Bootstrap UCL	4342
Anderson-Darling Test Statistic	2.839	95% Bootstrap-t UCL	4768
Anderson-Darling 5% Critical Value	0.849	95% Hall's Bootstrap UCL	4635
Kolmogorov-Smirnov Test Statistic	0.179	95% Percentile Bootstrap UCL	4333

Kolmogorov-Smirnov 5% Critical Value	0.112	95% BCA Bootstrap UCL	4777
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	6323
		97.5% Chebyshev(Mean, Sd) UCL	7693
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	10383
95% Approximate Gamma UCL (Use when n >= 40)	4477		
95% Adjusted Gamma UCL (Use when n < 40)	4508		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	6323

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	74	Number of Distinct Observations	73
Number of Missing Values	37		

Raw Statistics		**Log-transformed Statistics**	
Minimum	9280	Minimum of Log Data	9.136
Maximum	280000	Maximum of Log Data	12.54
Mean	67123	Mean of log Data	10.71
Geometric Mean	44685	SD of log Data	0.875
Median	32550		
SD	66522		
Std. Error of Mean	7733		
Coefficient of Variation	0.991		
Skewness	1.517		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.255	Lilliefors Test Statistic	0.161
Lilliefors Critical Value	0.103	Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	80007	95% H-UCL	81583
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	98279
95% Adjusted-CLT UCL (Chen-1995)	81300	97.5% Chebyshev (MVUE) UCL	112650
95% Modified-t UCL (Johnson-1978)	80234	99% Chebyshev (MVUE) UCL	140879
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.325	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	50660		
MLE of Mean	67123		
MLE of Standard Deviation	58314		
nu star	196.1		
Approximate Chi Square Value (.05)	164.7	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	79843
Adjusted Chi Square Value	164.1	95% Jackknife UCL	80007
		95% Standard Bootstrap UCL	79516

Anderson-Darling Test Statistic	3.946	95% Bootstrap-t UCL	81588
Anderson-Darling 5% Critical Value	0.772	95% Hall's Bootstrap UCL	80626
Kolmogorov-Smirnov Test Statistic	0.204	95% Percentile Bootstrap UCL	81033
Kolmogorov-Smirnov 5% Critical Value	0.106	95% BCA Bootstrap UCL	81207
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	100831
		97.5% Chebyshev(Mean, Sd) UCL	115416
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	144066
95% Approximate Gamma UCL (Use when n >= 40)	79920		
95% Adjusted Gamma UCL (Use when n < 40)	80197		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	100831

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and laci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics			
Number of Valid Data	56	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	29
Number of Missing Values	53	Percent Non-Detects	51.79%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.26	Minimum Detected	-1.347
Maximum Detected	1430	Maximum Detected	7.265
Mean of Detected	68.75	Mean of Detected	1.441
SD of Detected	274.5	SD of Detected	2.051
Minimum Non-Detect	0.14	Minimum Non-Detect	-1.966
Maximum Non-Detect	3.2	Maximum Non-Detect	1.163
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	43
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	76.79%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.265	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	33.38	Mean	0.149
SD	191.8	SD	1.964
95% DL/2 (t) UCL	76.26	95% H-Stat (DL/2) UCL	21.15
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.826
		SD in Log Scale	2.674
		Mean in Original Scale	33.18
		SD in Original Scale	191.9
		95% t UCL	76.07
		95% Percentile Bootstrap UCL	82.97
		95% BCA Bootstrap UCL	111.8
		95% H-UCL	90.94

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.25	**Data appear Lognormal at 5% Significance Level**	
Theta Star	274.5		
nu star	13.53		

A-D Test Statistic	3.546	**Nonparametric Statistics**	
5% A-D Critical Value	0.873	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.873	Mean	33.32
5% K-S Critical Value	0.184	SD	190.1
Data not Gamma Distributed at 5% Significance Level		SE of Mean	25.89
		95% KM (t) UCL	76.63
Assuming Gamma Distribution		95% KM (z) UCL	75.9
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	76.17
Minimum	0.000001	95% KM (bootstrap t) UCL	427.7
Maximum	1430	95% KM (BCA) UCL	84.44
Mean	33.15	95% KM (Percentile Bootstrap) UCL	84.19
Median	0.000001	95% KM (Chebyshev) UCL	146.2
SD	191.9	97.5% KM (Chebyshev) UCL	195
k star	0.0908	99% KM (Chebyshev) UCL	290.9
Theta star	365.1		
Nu star	10.17	**Potential UCLs to Use**	
AppChi2	4.047	99% KM (Chebyshev) UCL	290.9
95% Gamma Approximate UCL (Use when n >= 40)	83.27		
95% Adjusted Gamma UCL (Use when n < 40)	85.43		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Data	74	Number of Detected Data	71
Number of Distinct Detected Data	71	Number of Non-Detect Data	3
Number of Missing Values	37	Percent Non-Detects	4.05%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	18.2	Minimum Detected	2.901
Maximum Detected	40000	Maximum Detected	10.6
Mean of Detected	1746	Mean of Detected	5.798
SD of Detected	5955	SD of Detected	1.584
Minimum Non-Detect	4.3	Minimum Non-Detect	1.459
Maximum Non-Detect	23.4	Maximum Non-Detect	3.153
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	69
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	6.76%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.392	Lilliefors Test Statistic	0.0809
5% Lilliefors Critical Value	0.105	5% Lilliefors Critical Value	0.105
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1676	Mean	5.635
SD	5842	SD	1.75
95% DL/2 (t) UCL	2807	95% H-Stat (DL/2) UCL	2441
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1382	Mean in Log Scale	5.647
SD	6052	SD in Log Scale	1.717
95% MLE (t) UCL	2554	Mean in Original Scale	1676
95% MLE (Tiku) UCL	2441	SD in Original Scale	5842
		95% t UCL	2807
		95% Percentile Bootstrap UCL	2895
		95% BCA Bootstrap UCL	3477
		95% H UCL	2292
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.388	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4501		
nu star	55.1		
A-D Test Statistic	6.263	**Nonparametric Statistics**	
5% A-D Critical Value	0.842	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.842	Mean	1676
5% K-S Critical Value	0.113	SD	5802
Data not Gamma Distributed at 5% Significance Level		SE of Mean	679.3
		95% KM (t) UCL	2808
Assuming Gamma Distribution		95% KM (z) UCL	2794
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2808
Minimum	0.000001	95% KM (bootstrap t) UCL	5898
Maximum	40000	95% KM (BCA) UCL	2848
Mean	1676	95% KM (Percentile Bootstrap) UCL	2863
Median	264	95% KM (Chebyshev) UCL	4637
SD	5842	97.5% KM (Chebyshev) UCL	5918
k star	0.284	99% KM (Chebyshev) UCL	8435
Theta star	5895		
Nu star	42.07	**Potential UCLs to Use**	
AppChi2	28.2	97.5% KM (Chebyshev) UCL	5918
95% Gamma Approximate UCL (Use when n >= 40)	2500		
95% Adjusted Gamma UCL (Use when n < 40)	2520		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

BAP Equivalent - Half ND

General Statistics

Number of Valid Data	69	Number of Detected Data	56
Number of Distinct Detected Data	56	Number of Non-Detect Data	13
Number of Missing Values	42	Percent Non-Detects	18.84%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	72.32	Minimum Detected	4.281
Maximum Detected	5809	Maximum Detected	8.667
Mean of Detected	815.4	Mean of Detected	6.193
SD of Detected	1025	SD of Detected	0.983
Minimum Non-Detect	55	Minimum Non-Detect	4.007
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	39
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	30
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	56.52%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.256	Lilliefors Test Statistic	0.089
5% Lilliefors Critical Value	0.118	5% Lilliefors Critical Value	0.118
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	675.2	Mean	5.769
SD	967.4	SD	1.295
95% DL/2 (t) UCL	869.4	95% H-Stat (DL/2) UCL	1030
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	5.831
		SD in Log Scale	1.18
		Mean in Original Scale	676.8
		SD in Original Scale	966.2
		95% t UCL	870.8
		95% Percentile Bootstrap UCL	877.6
		95% BCA Bootstrap UCL	916.4
		95% H-UCL	933.5
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.068	**Data appear Lognormal at 5% Significance Level**	
Theta Star	763.7		
nu star	119.6		
A-D Test Statistic	1.661	**Nonparametric Statistics**	
5% A-D Critical Value	0.777	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.777	Mean	680.5
5% K-S Critical Value	0.122	SD	957.2
Data not Gamma Distributed at 5% Significance Level		SE of Mean	116.3
		95% KM (t) UCL	874.4
Assuming Gamma Distribution		95% KM (z) UCL	871.8
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	873.5
Minimum	0.000001	95% KM (bootstrap t) UCL	957.9
Maximum	5809	95% KM (BCA) UCL	889.3
Mean	661.7	95% KM (Percentile Bootstrap) UCL	872.3
Median	333.7	95% KM (Chebyshev) UCL	1187
SD	976	97.5% KM (Chebyshev) UCL	1407
k star	0.185	99% KM (Chebyshev) UCL	1838

Theta star	3579		
Nu star	25.52	**Potential UCLs to Use**	
AppChi2	15.01	95% KM (Chebyshev) UCL	1187
95% Gamma Approximate UCL (Use when n >= 40)	1125		
95% Adjusted Gamma UCL (Use when n < 40)	1138		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Post-Remedial EPCs for Exposure Scenario 1

Entire Site

Surface Soil Post-Remedial EPCs

for

Exposure Scenario 1

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	H:\Portsmouth\OU7 FS risk\datasets converted\surface soil data copc.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

LEAD

General Statistics

Number of Valid Data	51	Number of Detected Data	50
Number of Distinct Detected Data	49	Number of Non-Detect Data	1
Number of Missing Values	14	Percent Non-Detects	1.96%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	6.1	Minimum Detected	1.808
Maximum Detected	2296	Maximum Detected	7.739
Mean of Detected	264.4	Mean of Detected	4.648
SD of Detected	436.9	SD of Detected	1.424
Minimum Non-Detect	21.2	Minimum Non-Detect	3.054
Maximum Non-Detect	21.2	Maximum Non-Detect	3.054

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.591	Shapiro Wilk Test Statistic	0.973
5% Shapiro Wilk Critical Value	0.947	5% Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	259.4	Mean	4.603
SD	434	SD	1.445
95% DL/2 (t) UCL	361.3	95% H-Stat (DL/2) UCL	504.1
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	194.3	Mean in Log Scale	4.61
SD	498.6	SD in Log Scale	1.436
95% MLE (t) UCL	311.3	Mean in Original Scale	259.5
95% MLE (Tiku) UCL	309	SD in Original Scale	433.9
		95% t UCL	361.3
		95% Percentile Bootstrap UCL	366.5
		95% BCA Bootstrap UCL	402.4
		95% H UCL	497.8
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.63	**Data appear Lognormal at 5% Significance Level**	
Theta Star	419.5		
nu star	63.03		
A-D Test Statistic	1.181	**Nonparametric Statistics**	
5% A-D Critical Value	0.801	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.801	Mean	259.5
5% K-S Critical Value	0.131	SD	429.7
Data not Gamma Distributed at 5% Significance Level		SE of Mean	60.78
		95% KM (t) UCL	361.3
Assuming Gamma Distribution		95% KM (z) UCL	359.4
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	361.3
Minimum	0.000001	95% KM (bootstrap t) UCL	426
Maximum	2296	95% KM (BCA) UCL	361.6
Mean	259.2	95% KM (Percentile Bootstrap) UCL	368
Median	98.1	95% KM (Chebyshev) UCL	524.4
SD	434.1	97.5% KM (Chebyshev) UCL	639
k star	0.483	99% KM (Chebyshev) UCL	864.2
Theta star	536.4		
Nu star	49.3	**Potential UCLs to Use**	
AppChi2	34.18	95% KM (Chebyshev) UCL	524.4
95% Gamma Approximate UCL	373.9		
95% Adjusted Gamma UCL	378		
Note: DL/2 is not a recommended method.			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
For additional insight, the user may want to consult a statistician.			

Subsurface Soil Post-Remedial EPCs
for
Exposure Scenario 1

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

BAP TEQ-Half ND

General Statistics

Number of Valid Data	74	Number of Detected Data	61
Number of Distinct Detected Data	60	Number of Non-Detect Data	13
Number of Missing Values	42	Percent Non-Detects	17.57%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	7.728	Minimum Detected	2.045
Maximum Detected	5809	Maximum Detected	8.667
Mean of Detected	694.4	Mean of Detected	5.885
SD of Detected	930.6	SD of Detected	1.291
Minimum Non-Detect	55	Minimum Non-Detect	4.007
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	45
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	29
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	60.81%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.251	Lilliefors Test Statistic	0.148
5% Lilliefors Critical Value	0.113	5% Lilliefors Critical Value	0.113
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	584.9	Mean	5.545
SD	877.2	SD	1.424
95% DL/2 (t) UCL	754.8	95% H-Stat (DL/2) UCL	1107
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	5.534
		SD in Log Scale	1.415
		Mean in Original Scale	582.1
		SD in Original Scale	878.6
		95% t UCL	752.2
		95% Percentile Bootstrap UCL	750.5
		95% BCA Bootstrap UCL	811.6
		95% H-UCL	1077
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.857	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	809.8		
nu star	104.6		

A-D Test Statistic	1.072	**Nonparametric Statistics**	
5% A-D Critical Value	0.785	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.785	Mean	581.1
5% K-S Critical Value	0.118	SD	873.8
Data not Gamma Distributed at 5% Significance Level		SE of Mean	102.5
		95% KM (t) UCL	751.8
Assuming Gamma Distribution		95% KM (z) UCL	749.7
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	751.6
Minimum	0.000001	95% KM (bootstrap t) UCL	829.3
Maximum	5809	95% KM (BCA) UCL	753.1
Mean	572.4	95% KM (Percentile Bootstrap) UCL	760.6
Median	266.9	95% KM (Chebyshev) UCL	1028
SD	884.6	97.5% KM (Chebyshev) UCL	1221
k star	0.19	99% KM (Chebyshev) UCL	1601
Theta star	3005		
Nu star	28.19	**Potential UCLs to Use**	
AppChi2	17.07	95% KM (Chebyshev) UCL	1028
95% Gamma Approximate UCL (Use when n >= 40)	944.9		
95% Adjusted Gamma UCL (Use when n < 40)	954.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets
User Selected Options	
From File	H:\Portsmouth\OU7 FS risk\update appendix A\dioxins.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO-2005 - HALFND

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	99		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.876	Minimum of Log Data	-0.132
Maximum	33.97	Maximum of Log Data	3.525
Mean	6.108	Mean of log Data	1.341
Median	3.559	SD of log Data	0.912
SD	8.614		
Std. Error of Mean	2.389		
Coefficient of Variation	1.41		
Skewness	3.264		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.528	Shapiro Wilk Test Statistic	0.922
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.37	95% H-UCL	11.78
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.1
95% Adjusted-CLT UCL (Chen-1995)	12.35	97.5% Chebyshev (MVUE) UCL	14.93
95% Modified-t UCL (Johnson-1978)	10.73	99% Chebyshev (MVUE) UCL	20.5
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.98	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	6.236		
MLE of Mean	6.108		
MLE of Standard Deviation	6.171		
nu star	25.47		
Approximate Chi Square Value (.05)	14.97	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	10.04
Adjusted Chi Square Value	13.83	95% Jackknife UCL	10.37
		95% Standard Bootstrap UCL	9.917
Anderson-Darling Test Statistic	0.951	95% Bootstrap-t UCL	21.14
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	25.12
Kolmogorov-Smirnov Test Statistic	0.216	95% Percentile Bootstrap UCL	10.66
Kolmogorov-Smirnov 5% Critical Value	0.242	95% BCA Bootstrap UCL	11.88
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.52
		97.5% Chebyshev(Mean, Sd) UCL	21.03
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29.88

95% Approximate Gamma UCL	10.39
95% Adjusted Gamma UCL	11.24
Potential UCL to Use	Use 95% Approximate Gamma UCL 10.39

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Total Aroclor Half ND

General Statistics

Number of Valid Data	88	Number of Detected Data	18
Number of Distinct Detected Data	13	Number of Non-Detect Data	70
Number of Missing Values	28	Percent Non-Detects	79.55%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	67.5	Minimum Detected	4.212
Maximum Detected	965	Maximum Detected	6.872
Mean of Detected	241.6	Mean of Detected	5.212
SD of Detected	218.9	SD of Detected	0.737
Minimum Non-Detect	52.95	Minimum Non-Detect	3.969
Maximum Non-Detect	297	Maximum Non-Detect	5.694
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	85
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	96.59%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.686	Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	90.76	Mean	4.115
SD	125.7	SD	0.781
95% DL/2 (t) UCL	113	95% H-Stat (DL/2) UCL	98.65
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	3.333
		SD in Log Scale	1.132
		Mean in Original Scale	65.46
		SD in Original Scale	132.4
		95% t UCL	88.93
		95% Percentile Bootstrap UCL	91.88
		95% BCA Bootstrap UCL	99.73
		95% H-UCL	70.86

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.674	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	144.3		
nu star	60.28		

A-D Test Statistic	0.97	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	104.1
5% K-S Critical Value	0.206	SD	119.1
Data not Gamma Distributed at 5% Significance Level		SE of Mean	13.1
		95% KM (t) UCL	125.8
Assuming Gamma Distribution		95% KM (z) UCL	125.6
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	122.9
Minimum	0.000001	95% KM (bootstrap t) UCL	140.8
Maximum	965	95% KM (BCA) UCL	132.8
Mean	49.41	95% KM (Percentile Bootstrap) UCL	127.6
Median	0.000001	95% KM (Chebyshev) UCL	161.2
SD	137.7	97.5% KM (Chebyshev) UCL	185.9
k star	0.0675	99% KM (Chebyshev) UCL	234.4
Theta star	732.2		
Nu star	11.88	**Potential UCLs to Use**	
AppChi2	5.146	95% KM (t) UCL	125.8
95% Gamma Approximate UCL (Use when n >= 40)	114	95% KM (% Bootstrap) UCL	127.6
95% Adjusted Gamma UCL (Use when n < 40)	115.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
From File	H:\Portsmouth\OU7 FS risk\datasets converted\subsurface soil data copc.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

ANTIMONY

General Statistics

Number of Valid Data	60	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	33
Number of Missing Values	56	Percent Non-Detects	55.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.26	Minimum Detected	-1.347
Maximum Detected	1430	Maximum Detected	7.265
Mean of Detected	68.75	Mean of Detected	1.441
SD of Detected	274.5	SD of Detected	2.051
Minimum Non-Detect	0.11	Minimum Non-Detect	-2.207
Maximum Non-Detect	3.2	Maximum Non-Detect	1.163
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	47
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	78.33%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.265	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	31.16	Mean	-0.0149
SD	185.4	SD	2
95% DL/2 (t) UCL	71.16	95% H-Stat (DL/2) UCL	20.02
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.165
		SD in Log Scale	2.793
		Mean in Original Scale	30.96
		SD in Original Scale	185.4
		95% t UCL	70.97
		95% Percentile Bootstrap UCL	77.35
		95% BCA Bootstrap UCL	103.8
		95% H-UCL	109.6
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.25	Data appear Lognormal at 5% Significance Level	
Theta Star	274.5		
nu star	13.53		

A-D Test Statistic	3.546	**Nonparametric Statistics**	
5% A-D Critical Value	0.873	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.873	Mean	31.11
5% K-S Critical Value	0.184	SD	183.8
Data not Gamma Distributed at 5% Significance Level		SE of Mean	24.19
		95% KM (t) UCL	71.53
Assuming Gamma Distribution		95% KM (z) UCL	70.89
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	71.07
Minimum	0.000001	95% KM (bootstrap t) UCL	400.9
Maximum	1430	95% KM (BCA) UCL	79.79
Mean	30.94	95% KM (Percentile Bootstrap) UCL	77.97
Median	0.000001	95% KM (Chebyshev) UCL	136.5
SD	185.4	97.5% KM (Chebyshev) UCL	182.2
k star	0.0874	99% KM (Chebyshev) UCL	271.8
Theta star	353.9		
Nu star	10.49	**Potential UCLs to Use**	
AppChi2	4.25	97.5% KM (Chebyshev) UCL	182.2
95% Gamma Approximate UCL	76.36		
95% Adjusted Gamma UCL	78.15		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

LEAD

General Statistics

Number of Valid Data	78	Number of Detected Data	75
Number of Distinct Detected Data	74	Number of Non-Detect Data	3
Number of Missing Values	38	Percent Non-Detects	3.85%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	18.2	Minimum Detected	2.901
Maximum Detected	40000	Maximum Detected	10.6
Mean of Detected	1645	Mean of Detected	5.71
SD of Detected	5806	SD of Detected	1.561
Minimum Non-Detect	4.3	Minimum Non-Detect	1.459
Maximum Non-Detect	23.4	Maximum Non-Detect	3.153
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	73
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	6.41%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.39	Lilliefors Test Statistic	0.0951
5% Lilliefors Critical Value	0.102	5% Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1582	Mean	5.559
SD	5701	SD	1.715
95% DL/2 (t) UCL	2657	95% H-Stat (DL/2) UCL	2058
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1309	Mean in Log Scale	5.569
SD	5893	SD in Log Scale	1.687
95% MLE (t) UCL	2420	Mean in Original Scale	1582
95% MLE (Tiku) UCL	2311	SD in Original Scale	5701
		95% t UCL	2657
		95% Percentile Bootstrap UCL	2800
		95% BCA Bootstrap UCL	3364
		95% H UCL	1952
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.383	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4294		
nu star	57.46		
A-D Test Statistic	7.254	**Nonparametric Statistics**	
5% A-D Critical Value	0.844	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.844	Mean	1582
5% K-S Critical Value	0.111	SD	5664
Data not Gamma Distributed at 5% Significance Level		SE of Mean	645.6
		95% KM (t) UCL	2657
Assuming Gamma Distribution		95% KM (z) UCL	2644
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2657
Minimum	0.000001	95% KM (bootstrap t) UCL	5596
Maximum	40000	95% KM (BCA) UCL	2798
Mean	1582	95% KM (Percentile Bootstrap) UCL	2738
Median	239	95% KM (Chebyshev) UCL	4397
SD	5701	97.5% KM (Chebyshev) UCL	5614
k star	0.286	99% KM (Chebyshev) UCL	8006
Theta star	5534		
Nu star	44.58	**Potential UCLs to Use**	
AppChi2	30.27	97.5% KM (Chebyshev) UCL	5614
95% Gamma Approximate UCL	2330		
95% Adjusted Gamma UCL	2347		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options	
From File	H:\Portsmouth\OU7 FS risk\datasets converted\subsurface soil data copc 1.xls.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

COPPER

General Statistics

Number of Valid Observations	78	Number of Distinct Observations	73
Number of Missing Values	38		

Raw Statistics		Log-transformed Statistics	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	32400	Maximum of Log Data	10.39
Mean	2618	Mean of log Data	6.031
Median	271	SD of log Data	2.025
SD	5790		
Std. Error of Mean	655.6		
Coefficient of Variation	2.212		
Skewness	3.532		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Lilliefors Test Statistic	0.327	Lilliefors Test Statistic	0.113
Lilliefors Critical Value	0.1	Lilliefors Critical Value	0.1
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3710	95% H-UCL	7191
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7637
95% Adjusted-CLT UCL (Chen-1995)	3977	97.5% Chebyshev (MVUE) UCL	9644
95% Modified-t UCL (Johnson-1978)	3753	99% Chebyshev (MVUE) UCL	13587
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.358	Data do not follow a Discernable Distribution (0.05)	
Theta Star	7315		
MLE of Mean	2618		
MLE of Standard Deviation	4376		
nu star	55.83		
Approximate Chi Square Value (.05)	39.66	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0469	95% CLT UCL	3696
Adjusted Chi Square Value	39.4	95% Jackknife UCL	3710
		95% Standard Bootstrap UCL	3665
Anderson-Darling Test Statistic	3.657	95% Bootstrap-t UCL	4329
Anderson-Darling 5% Critical Value	0.85	95% Hall's Bootstrap UCL	4028
Kolmogorov-Smirnov Test Statistic	0.184	95% Percentile Bootstrap UCL	3804
Kolmogorov-Smirnov 5% Critical Value	0.109	95% BCA Bootstrap UCL	4010
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5476
		97.5% Chebyshev(Mean, Sd) UCL	6712
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9141

95% Approximate Gamma UCL	3686		
95% Adjusted Gamma UCL	3710		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	5476

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

IRON

General Statistics

Number of Valid Observations	78	Number of Distinct Observations	74
Number of Missing Values	38		
Raw Statistics		**Log-transformed Statistics**	
Minimum	5500	Minimum of Log Data	8.613
Maximum	280000	Maximum of Log Data	12.54
Mean	59307	Mean of log Data	10.52
Median	28000	SD of log Data	0.947
SD	64522		
Std. Error of Mean	7306		
Coefficient of Variation	1.088		
Skewness	1.783		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.271	Lilliefors Test Statistic	0.139
Lilliefors Critical Value	0.1	Lilliefors Critical Value	0.1
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	71471	95% H-UCL	74033
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	89601
95% Adjusted-CLT UCL (Chen-1995)	72900	97.5% Chebyshev (MVUE) UCL	103351
95% Modified-t UCL (Johnson-1978)	71716	99% Chebyshev (MVUE) UCL	130362
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.174	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	50496		
MLE of Mean	59307		
MLE of Standard Deviation	54725		
nu star	183.2		
Approximate Chi Square Value (.05)	152.9	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0469	95% CLT UCL	71324
Adjusted Chi Square Value	152.4	95% Jackknife UCL	71471
		95% Standard Bootstrap UCL	71248
Anderson-Darling Test Statistic	3.784	95% Bootstrap-t UCL	73688
Anderson-Darling 5% Critical Value	0.777	95% Hall's Bootstrap UCL	73327
Kolmogorov-Smirnov Test Statistic	0.198	95% Percentile Bootstrap UCL	71356
Kolmogorov-Smirnov 5% Critical Value	0.104	95% BCA Bootstrap UCL	73128
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	91152

07			97.5% Chebyshev(Mean, Sd) UCL	104932
08	**Assuming Gamma Distribution**		99% Chebyshev(Mean, Sd) UCL	131998
09	95% Approximate Gamma UCL	71063		
10	95% Adjusted Gamma UCL	71305		
11				
12	**Potential UCL to Use**		Use 95% Chebyshev (Mean, Sd) UCL	91152
13				
14	**Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.**			
15	**These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)**			
16	**and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.**			
17				

Post-Remedial EPCs for Exposure Scenario 2, Exposure Unit 2

Remainder of Site Excluding the Filled Area in the Vincinity of Former Building 237

Surface Soil Post-Remedial EPCs

for

Exposure Scenario 2: Exposure Unit 2

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Data	44	Number of Detected Data	43
Number of Distinct Detected Data	43	Number of Non-Detect Data	1
Number of Missing Values	15	Percent Non-Detects	2.27%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	6.1	Minimum Detected	1.808
Maximum Detected	2296	Maximum Detected	7.739
Mean of Detected	297.8	Mean of Detected	4.811
SD of Detected	462.7	SD of Detected	1.417
Minimum Non-Detect	21.2	Minimum Non-Detect	3.054
Maximum Non-Detect	21.2	Maximum Non-Detect	3.054

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.621	Shapiro Wilk Test Statistic	0.979
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	291.3	Mean	4.756
SD	459.4	SD	1.448
95% DL/2 (t) UCL	407.7	95% H-Stat (DL/2) UCL	630.9
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	238.9	Mean in Log Scale	4.762
SD	511.5	SD in Log Scale	1.438
95% MLE (t) UCL	368.6	Mean in Original Scale	291.4
95% MLE (Tiku) UCL	364	SD in Original Scale	459.3
		95% t UCL	407.8
		95% Percentile Bootstrap UCL	408.8
		95% BCA Bootstrap UCL	445.8
		95% H UCL	621.2
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.653	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	456.3		
nu star	56.13		
A-D Test Statistic	0.889	**Nonparametric Statistics**	
5% A-D Critical Value	0.796	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.796	Mean	291.3
5% K-S Critical Value	0.141	SD	454.1
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	69.27
		95% KM (t) UCL	407.8
Assuming Gamma Distribution		95% KM (z) UCL	405.3
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	407.7
Minimum	0.000001	95% KM (bootstrap t) UCL	478.3
Maximum	2296	95% KM (BCA) UCL	423.9
Mean	291	95% KM (Percentile Bootstrap) UCL	416.7
Median	103.5	95% KM (Chebyshev) UCL	593.3
SD	459.5	97.5% KM (Chebyshev) UCL	723.9
k star	0.476	99% KM (Chebyshev) UCL	980.5
Theta star	611		
Nu star	41.92	**Potential UCLs to Use**	
AppChi2	28.08	95% KM (Chebyshev) UCL	593.3
95% Gamma Approximate UCL (Use when n >= 40)	434.5		
95% Adjusted Gamma UCL (Use when n < 40)	440.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Subsurface Soil Post-Remedial EPCs

for

Exposure Scenario 2: Exposure Unit 2

	General UCL Statistics for Data Sets with Non-Detects		
User Selected Options			
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W		
Full Precision	OFF		
Confidence Coefficient	95%		
Number of Bootstrap Operations	2000		

BAP Equivalent-Half ND

General Statistics

Number of Valid Data	71	Number of Detected Data	58
Number of Distinct Detected Data	57	Number of Non-Detect Data	13
Number of Missing Values	42	Percent Non-Detects	18.31%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	15	Minimum Detected	2.708
Maximum Detected	5809	Maximum Detected	8.667
Mean of Detected	725.6	Mean of Detected	6.017
SD of Detected	943.8	SD of Detected	1.128
Minimum Non-Detect	55	Minimum Non-Detect	4.007
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	42
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	29
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	59.15%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.251	Lilliefors Test Statistic	0.112
5% Lilliefors Critical Value	0.116	5% Lilliefors Critical Value	0.116
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	605.8	Mean	5.638
SD	889.3	SD	1.34
95% DL/2 (t) UCL	781.8	95% H-Stat (DL/2) UCL	1045
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	5.663
		SD in Log Scale	1.282
		Mean in Original Scale	605
		SD in Original Scale	889.6
		95% t UCL	781
		95% Percentile Bootstrap UCL	790
		95% BCA Bootstrap UCL	856.9
		95% H-UCL	967.2
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.97	Data appear Lognormal at 5% Significance Level	
Theta Star	747.9		
nu star	112.5		

A-D Test Statistic	1.219	**Nonparametric Statistics**	
5% A-D Critical Value	0.779	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.779	Mean	602.5
5% K-S Critical Value	0.12	SD	885.4
Data not Gamma Distributed at 5% Significance Level		SE of Mean	106
		95% KM (t) UCL	779.3
Assuming Gamma Distribution		95% KM (z) UCL	777
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	779
Minimum	0.000001	95% KM (bootstrap t) UCL	851.4
Maximum	5809	95% KM (BCA) UCL	809.1
Mean	592.8	95% KM (Percentile Bootstrap) UCL	789.8
Median	306.6	95% KM (Chebyshev) UCL	1065
SD	897.3	97.5% KM (Chebyshev) UCL	1265
k star	0.188	99% KM (Chebyshev) UCL	1658
Theta star	3160		
Nu star	26.64	**Potential UCLs to Use**	
AppChi2	15.87	95% KM (Chebyshev) UCL	1065
95% Gamma Approximate UCL (Use when n >= 40)	994.8		
95% Adjusted Gamma UCL (Use when n < 40)	1006		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Total Aroclor Half ND

General Statistics

Number of Valid Data	86	Number of Detected Data	18
Number of Distinct Detected Data	13	Number of Non-Detect Data	68
Number of Missing Values	27	Percent Non-Detects	79.07%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	67.5	Minimum Detected	4.212
Maximum Detected	965	Maximum Detected	6.872
Mean of Detected	241.6	Mean of Detected	5.212
SD of Detected	218.9	SD of Detected	0.737
Minimum Non-Detect	52.95	Minimum Non-Detect	3.969
Maximum Non-Detect	297	Maximum Non-Detect	5.694
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	83
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	96.51%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.686	Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	91.35	Mean	4.113
SD	127.1	SD	0.79
95% DL/2 (t) UCL	114.1	95% H-Stat (DL/2) UCL	99.62
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	3.353
		SD in Log Scale	1.132
		Mean in Original Scale	66.62
		SD in Original Scale	133.7
		95% t UCL	90.6
		95% Percentile Bootstrap UCL	92.64
		95% BCA Bootstrap UCL	100.6
		95% H-UCL	72.55
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.674	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	144.3		
nu star	60.28		
A-D Test Statistic	0.97	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	104.9
5% K-S Critical Value	0.206	SD	120.3
Data not Gamma Distributed at 5% Significance Level		SE of Mean	13.39
		95% KM (t) UCL	127.1
Assuming Gamma Distribution		95% KM (z) UCL	126.9
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	124.1
Minimum	0.000001	95% KM (bootstrap t) UCL	145.7
Maximum	965	95% KM (BCA) UCL	133.6
Mean	50.56	95% KM (Percentile Bootstrap) UCL	129
Median	0.000001	95% KM (Chebyshev) UCL	163.2
SD	139.1	97.5% KM (Chebyshev) UCL	188.5
k star	0.0679	99% KM (Chebyshev) UCL	238.1
Theta star	744.9		
Nu star	11.67	**Potential UCLs to Use**	
AppChi2	5.013	95% KM (t) UCL	127.1
95% Gamma Approximate UCL (Use when n >= 40)	117.7	95% KM (% Bootstrap) UCL	129
95% Adjusted Gamma UCL (Use when n < 40)	119.5		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Antimony

General Statistics

Number of Valid Data	58	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	31
Number of Missing Values	55	Percent Non-Detects	53.45%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.26	Minimum Detected	-1.347
Maximum Detected	1430	Maximum Detected	7.265
Mean of Detected	68.75	Mean of Detected	1.441
SD of Detected	274.5	SD of Detected	2.051
Minimum Non-Detect	0.14	Minimum Non-Detect	-1.966
Maximum Non-Detect	3.2	Maximum Non-Detect	1.163
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	45
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	77.59%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.265	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	32.23	Mean	0.0836
SD	188.5	SD	1.96
95% DL/2 (t) UCL	73.62	95% H-Stat (DL/2) UCL	19.68
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.987
		SD in Log Scale	2.729
		Mean in Original Scale	32.03
		SD in Original Scale	188.6
		95% t UCL	73.43
		95% Percentile Bootstrap UCL	81.38
		95% BCA Bootstrap UCL	105.1
		95% H-UCL	98.84
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.25	**Data appear Lognormal at 5% Significance Level**	
Theta Star	274.5		
nu star	13.53		
A-D Test Statistic	3.546	**Nonparametric Statistics**	
5% A-D Critical Value	0.873	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.873	Mean	32.18
5% K-S Critical Value	0.184	SD	186.9
Data not Gamma Distributed at 5% Significance Level		SE of Mean	25.01
		95% KM (t) UCL	73.99
Assuming Gamma Distribution		95% KM (z) UCL	73.31
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	73.53
Minimum	0.000001	95% KM (bootstrap t) UCL	418.6
Maximum	1430	95% KM (BCA) UCL	84.37
Mean	32	95% KM (Percentile Bootstrap) UCL	81.02
Median	0.000001	95% KM (Chebyshev) UCL	141.2
SD	188.6	97.5% KM (Chebyshev) UCL	188.4
k star	0.089	99% KM (Chebyshev) UCL	281

Theta star	359.5		
Nu star	10.33	**Potential UCLs to Use**	
AppChi2	4.146	99% KM (Chebyshev) UCL	281
95% Gamma Approximate UCL (Use when n >= 40)	79.7		
95% Adjusted Gamma UCL (Use when n < 40)	81.66		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Data	76	Number of Detected Data	73
Number of Distinct Detected Data	72	Number of Non-Detect Data	3
Number of Missing Values	37	Percent Non-Detects	3.95%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	18.2	Minimum Detected	2.901
Maximum Detected	40000	Maximum Detected	10.6
Mean of Detected	1685	Mean of Detected	5.724
SD of Detected	5881	SD of Detected	1.581
Minimum Non-Detect	4.3	Minimum Non-Detect	1.459
Maximum Non-Detect	23.4	Maximum Non-Detect	3.153
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	71
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	6.58%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.391	Lilliefors Test Statistic	0.0903
5% Lilliefors Critical Value	0.104	5% Lilliefors Critical Value	0.104
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1619	Mean	5.568
SD	5772	SD	1.736
95% DL/2 (t) UCL	2721	95% H-Stat (DL/2) UCL	2199
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1335	Mean in Log Scale	5.578
SD	5972	SD in Log Scale	1.711
95% MLE (t) UCL	2476	Mean in Original Scale	1619
95% MLE (Tiku) UCL	2365	SD in Original Scale	5772
		95% t UCL	2721
		95% Percentile Bootstrap UCL	2763
		95% BCA Bootstrap UCL	3228
		95% H UCL	2092

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.381	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4423		
nu star	55.62		
A-D Test Statistic	6.849	**Nonparametric Statistics**	
5% A-D Critical Value	0.844	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.844	Mean	1619
5% K-S Critical Value	0.112	SD	5733
Data not Gamma Distributed at 5% Significance Level		SE of Mean	662.2
		95% KM (t) UCL	2722
Assuming Gamma Distribution		95% KM (z) UCL	2708
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2722
Minimum	0.000001	95% KM (bootstrap t) UCL	5710
Maximum	40000	95% KM (BCA) UCL	2772
Mean	1618	95% KM (Percentile Bootstrap) UCL	2849
Median	257.5	95% KM (Chebyshev) UCL	4506
SD	5772	97.5% KM (Chebyshev) UCL	5755
k star	0.283	99% KM (Chebyshev) UCL	8208
Theta star	5722		
Nu star	42.99	**Potential UCLs to Use**	
AppChi2	28.96	97.5% KM (Chebyshev) UCL	5755
95% Gamma Approximate UCL (Use when n >= 40)	2403		
95% Adjusted Gamma UCL (Use when n < 40)	2421		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

General UCL Statistics for Full Data Sets

User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO-2005 Half ND

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	64		

Raw Statistics		Log-transformed Statistics	
Minimum	0.876	Minimum of Log Data	-0.132
Maximum	33.97	Maximum of Log Data	3.525
Mean	6.103	Mean of log Data	1.34
Geometric Mean	3.821	SD of log Data	0.911
Median	3.559		
SD	8.613		
Std. Error of Mean	2.389		
Coefficient of Variation	1.411		
Skewness	3.267		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.527	Shapiro Wilk Test Statistic	0.921
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.36	95% H-UCL	11.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.08
95% Adjusted-CLT UCL (Chen-1995)	12.35	97.5% Chebyshev (MVUE) UCL	14.91
95% Modified-t UCL (Johnson-1978)	10.72	99% Chebyshev (MVUE) UCL	20.46
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.98	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	6.229		
MLE of Mean	6.103		
MLE of Standard Deviation	6.165		
nu star	25.47		
Approximate Chi Square Value (.05)	14.98	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	10.03
Adjusted Chi Square Value	13.84	95% Jackknife UCL	10.36
		95% Standard Bootstrap UCL	9.863
Anderson-Darling Test Statistic	0.956	95% Bootstrap-t UCL	21.03
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	25.03
Kolmogorov-Smirnov Test Statistic	0.219	95% Percentile Bootstrap UCL	10.6
Kolmogorov-Smirnov 5% Critical Value	0.242	95% BCA Bootstrap UCL	12.79
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.52
		97.5% Chebyshev(Mean, Sd) UCL	21.02

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29.87
95% Approximate Gamma UCL (Use when n >= 40)	10.38		
95% Adjusted Gamma UCL (Use when n < 40)	11.23		
Potential UCL to Use		Use 95% Approximate Gamma UCL	10.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper

General Statistics

Number of Valid Observations	76	Number of Distinct Observations	71
Number of Missing Values	37		

Raw Statistics		**Log-transformed Statistics**	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	32400	Maximum of Log Data	10.39
Mean	2686	Mean of log Data	6.091
Geometric Mean	441.7	SD of log Data	2.016
Median	310		
SD	5851		
Std. Error of Mean	671.2		
Coefficient of Variation	2.179		
Skewness	3.483		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.324	Lilliefors Test Statistic	0.112
Lilliefors Critical Value	0.102	Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3804	95% H-UCL	7510
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	7972
95% Adjusted-CLT UCL (Chen-1995)	4076	97.5% Chebyshev (MVUE) UCL	10070
95% Modified-t UCL (Johnson-1978)	3848	99% Chebyshev (MVUE) UCL	14192
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.363	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	7389		
MLE of Mean	2686		
MLE of Standard Deviation	4455		
nu star	55.25		
Approximate Chi Square Value (.05)	39.17	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	3790
Adjusted Chi Square Value	38.91	95% Jackknife UCL	3804
		95% Standard Bootstrap UCL	3780
Anderson-Darling Test Statistic	3.374	95% Bootstrap-t UCL	4269
Anderson-Darling 5% Critical Value	0.849	95% Hall's Bootstrap UCL	4126
Kolmogorov-Smirnov Test Statistic	0.18	95% Percentile Bootstrap UCL	3887

Kolmogorov-Smirnov 5% Critical Value	0.11	95% BCA Bootstrap UCL	4067
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5611
		97.5% Chebyshev(Mean, Sd) UCL	6877
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9364
95% Approximate Gamma UCL (Use when n >= 40)	3788		
95% Adjusted Gamma UCL (Use when n < 40)	3814		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	5611

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	76	Number of Distinct Observations	72
Number of Missing Values	37		
Raw Statistics		**Log-transformed Statistics**	
Minimum	5500	Minimum of Log Data	8.613
Maximum	280000	Maximum of Log Data	12.54
Mean	60269	Mean of log Data	10.54
Geometric Mean	37702	SD of log Data	0.957
Median	28775		
SD	65097		
Std. Error of Mean	7467		
Coefficient of Variation	1.08		
Skewness	1.743		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.266	Lilliefors Test Statistic	0.133
Lilliefors Critical Value	0.102	Lilliefors Critical Value	0.102
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	72705	95% H-UCL	76109
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	92321
95% Adjusted-CLT UCL (Chen-1995)	74146	97.5% Chebyshev (MVUE) UCL	106713
95% Modified-t UCL (Johnson-1978)	72954	99% Chebyshev (MVUE) UCL	134983
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.166	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	51671		
MLE of Mean	60269		
MLE of Standard Deviation	55804		
nu star	177.3		
Approximate Chi Square Value (.05)	147.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	72551
Adjusted Chi Square Value	147	95% Jackknife UCL	72705
		95% Standard Bootstrap UCL	72267

Anderson-Darling Test Statistic	3.432	95% Bootstrap-t UCL	75167
Anderson-Darling 5% Critical Value	0.777	95% Hall's Bootstrap UCL	74478
Kolmogorov-Smirnov Test Statistic	0.194	95% Percentile Bootstrap UCL	73041
Kolmogorov-Smirnov 5% Critical Value	0.105	95% BCA Bootstrap UCL	74689
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	92817
		97.5% Chebyshev(Mean, Sd) UCL	106901
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	134566
95% Approximate Gamma UCL (Use when n >= 40)	72443		
95% Adjusted Gamma UCL (Use when n < 40)	72701		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	92817

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Post-Remedial EPCs for Exposure Scenario 3, Exposure Unit 2

Remainder of Site Excluding the Filled Area in the Vincinity of Former Building and the Adjacent Area South of Goodrich Avenue

Surface Soil Post-Remedial EPCs

for

Exposure Scenario 3: Exposure Unit 2

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lead

General Statistics

Number of Valid Data	40	Number of Detected Data	39
Number of Distinct Detected Data	39	Number of Non-Detect Data	1
Number of Missing Values	15	Percent Non-Detects	2.50%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	6.1	Minimum Detected	1.808
Maximum Detected	1690	Maximum Detected	7.432
Mean of Detected	262.9	Mean of Detected	4.767
SD of Detected	356.1	SD of Detected	1.403
Minimum Non-Detect	21.2	Minimum Non-Detect	3.054
Maximum Non-Detect	21.2	Maximum Non-Detect	3.054

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.688	Shapiro Wilk Test Statistic	0.969
5% Shapiro Wilk Critical Value	0.939	5% Shapiro Wilk Critical Value	0.939
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	256.6	Mean	4.707
SD	353.8	SD	1.437
95% DL/2 (t) UCL	350.8	95% H-Stat (DL/2) UCL	614.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	212.9	Mean in Log Scale	4.715
SD	399.9	SD in Log Scale	1.424
95% MLE (t) UCL	319.5	Mean in Original Scale	256.7
95% MLE (Tiku) UCL	317.2	SD in Original Scale	353.7
		95% t UCL	350.9
		95% Percentile Bootstrap UCL	351.5
		95% BCA Bootstrap UCL	375
		95% H UCL	602.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.705	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	373		
nu star	54.98		
A-D Test Statistic	0.485	**Nonparametric Statistics**	
5% A-D Critical Value	0.789	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.789	Mean	256.6
5% K-S Critical Value	0.147	SD	349.3
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	55.95
		95% KM (t) UCL	350.9
Assuming Gamma Distribution		95% KM (z) UCL	348.6
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	350.8
Minimum	0.000001	95% KM (bootstrap t) UCL	384.6
Maximum	1690	95% KM (BCA) UCL	363.5
Mean	256.3	95% KM (Percentile Bootstrap) UCL	356.1
Median	114.6	95% KM (Chebyshev) UCL	500.5
SD	354	97.5% KM (Chebyshev) UCL	606
k star	0.488	99% KM (Chebyshev) UCL	813.3
Theta star	525.4		
Nu star	39.02	**Potential UCLs to Use**	
AppChi2	25.72	95% KM (Chebyshev) UCL	500.5
95% Gamma Approximate UCL (Use when n >= 40)	388.9		
95% Adjusted Gamma UCL (Use when n < 40)	395.2		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Subsurface Soil Post-Remedial EPCs
for
Exposure Scenario 3: Exposure Unit 2

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	S:\Portsmouth - Debbie Cohen\OU7 RAA and FS\OU7 FS\Revised Draft files for DF\Appendix A\Appendix A.2\W
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Total Aroclor-Half ND

General Statistics			
Number of Valid Data	84	Number of Detected Data	18
Number of Distinct Detected Data	13	Number of Non-Detect Data	66
Number of Missing Values	27	Percent Non-Detects	78.57%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	67.5	Minimum Detected	4.212
Maximum Detected	965	Maximum Detected	6.872
Mean of Detected	241.6	Mean of Detected	5.212
SD of Detected	218.9	SD of Detected	0.737
Minimum Non-Detect	52.95	Minimum Non-Detect	3.969
Maximum Non-Detect	297	Maximum Non-Detect	5.694
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	81
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	96.43%

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.686	Shapiro Wilk Test Statistic	0.897
5% Shapiro Wilk Critical Value	0.897	5% Shapiro Wilk Critical Value	0.897
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	91.41	Mean	4.104
SD	128.6	SD	0.797
95% DL/2 (t) UCL	114.8	95% H-Stat (DL/2) UCL	99.69
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	3.37
		SD in Log Scale	1.136
		Mean in Original Scale	67.82
		SD in Original Scale	135.1
		95% t UCL	92.34
		95% Percentile Bootstrap UCL	94.69
		95% BCA Bootstrap UCL	99.18
		95% H-UCL	74.55
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.674	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	144.3		
nu star	60.28		

A-D Test Statistic	0.97	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	105.7
5% K-S Critical Value	0.206	SD	121.6
Data not Gamma Distributed at 5% Significance Level		SE of Mean	13.69
		95% KM (t) UCL	128.5
Assuming Gamma Distribution		95% KM (z) UCL	128.2
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	125.5
Minimum	0.000001	95% KM (bootstrap t) UCL	146.5
Maximum	965	95% KM (BCA) UCL	140.6
Mean	51.76	95% KM (Percentile Bootstrap) UCL	131.6
Median	0.000001	95% KM (Chebyshev) UCL	165.4
SD	140.6	97.5% KM (Chebyshev) UCL	191.2
k star	0.0683	99% KM (Chebyshev) UCL	241.9
Theta star	758		
Nu star	11.47	**Potential UCLs to Use**	
AppChi2	4.882	95% KM (t) UCL	128.5
95% Gamma Approximate UCL (Use when n >= 40)	121.6	95% KM (% Bootstrap) UCL	131.6
95% Adjusted Gamma UCL (Use when n < 40)	123.5		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets
User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

TEQ WHO-2005 - Half ND

General Statistics

Number of Valid Observations	13	Number of Distinct Observations	13
Number of Missing Values	64		

Raw Statistics		Log-transformed Statistics	
Minimum	0.876	Minimum of Log Data	-0.132
Maximum	33.97	Maximum of Log Data	3.525
Mean	6.103	Mean of log Data	1.34
Geometric Mean	3.821	SD of log Data	0.911
Median	3.559		
SD	8.613		
Std. Error of Mean	2.389		
Coefficient of Variation	1.411		
Skewness	3.267		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.527	Shapiro Wilk Test Statistic	0.921
Shapiro Wilk Critical Value	0.866	Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.36	95% H-UCL	11.76
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12.08
95% Adjusted-CLT UCL (Chen-1995)	12.35	97.5% Chebyshev (MVUE) UCL	14.91
95% Modified-t UCL (Johnson-1978)	10.72	99% Chebyshev (MVUE) UCL	20.46
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.98	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	6.229		
MLE of Mean	6.103		
MLE of Standard Deviation	6.165		
nu star	25.47		
Approximate Chi Square Value (.05)	14.98	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0301	95% CLT UCL	10.03
Adjusted Chi Square Value	13.84	95% Jackknife UCL	10.36
		95% Standard Bootstrap UCL	9.836
Anderson-Darling Test Statistic	0.956	95% Bootstrap-t UCL	21.15
Anderson-Darling 5% Critical Value	0.754	95% Hall's Bootstrap UCL	24.82
Kolmogorov-Smirnov Test Statistic	0.219	95% Percentile Bootstrap UCL	10.57
Kolmogorov-Smirnov 5% Critical Value	0.242	95% BCA Bootstrap UCL	12.78
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.52
		97.5% Chebyshev(Mean, Sd) UCL	21.02

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	29.87
95% Approximate Gamma UCL (Use when n >= 40)	10.38		
95% Adjusted Gamma UCL (Use when n < 40)	11.23		
Potential UCL to Use		Use 95% Approximate Gamma UCL	10.38

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Copper

General Statistics

Number of Valid Observations	74	Number of Distinct Observations	69
Number of Missing Values	37		

Raw Statistics		**Log-transformed Statistics**	
Minimum	17.3	Minimum of Log Data	2.851
Maximum	32400	Maximum of Log Data	10.39
Mean	2757	Mean of log Data	6.149
Geometric Mean	468	SD of log Data	2.008
Median	310		
SD	5915		
Std. Error of Mean	687.6		
Coefficient of Variation	2.146		
Skewness	3.433		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.322	Lilliefors Test Statistic	0.11
Lilliefors Critical Value	0.103	Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	3902	95% H-UCL	7864
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	8338
95% Adjusted-CLT UCL (Chen-1995)	4181	97.5% Chebyshev (MVUE) UCL	10537
95% Modified-t UCL (Johnson-1978)	3948	99% Chebyshev (MVUE) UCL	14857
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.369	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	7474		
MLE of Mean	2757		
MLE of Standard Deviation	4539		
nu star	54.58		
Approximate Chi Square Value (.05)	38.61	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	3888
Adjusted Chi Square Value	38.34	95% Jackknife UCL	3902
		95% Standard Bootstrap UCL	3857
Anderson-Darling Test Statistic	3.107	95% Bootstrap-t UCL	4458
Anderson-Darling 5% Critical Value	0.847	95% Hall's Bootstrap UCL	4168
Kolmogorov-Smirnov Test Statistic	0.174	95% Percentile Bootstrap UCL	3957

Kolmogorov-Smirnov 5% Critical Value	0.112	95% BCA Bootstrap UCL	4182
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5754
		97.5% Chebyshev(Mean, Sd) UCL	7050
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9598
95% Approximate Gamma UCL (Use when n >= 40)	3897		
95% Adjusted Gamma UCL (Use when n < 40)	3924		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	5754

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics

Number of Valid Observations	74	Number of Distinct Observations	70
Number of Missing Values	37		
Raw Statistics		**Log-transformed Statistics**	
Minimum	5500	Minimum of Log Data	8.613
Maximum	280000	Maximum of Log Data	12.54
Mean	61415	Mean of log Data	10.56
Geometric Mean	38471	SD of log Data	0.961
Median	29775		
SD	65598		
Std. Error of Mean	7626		
Coefficient of Variation	1.068		
Skewness	1.705		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Lilliefors Test Statistic	0.264	Lilliefors Test Statistic	0.13
Lilliefors Critical Value	0.103	Lilliefors Critical Value	0.103
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	74119	95% H-UCL	78395
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	95270
95% Adjusted-CLT UCL (Chen-1995)	75573	97.5% Chebyshev (MVUE) UCL	110303
95% Modified-t UCL (Johnson-1978)	74371	99% Chebyshev (MVUE) UCL	139833
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.168	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	52563		
MLE of Mean	61415		
MLE of Standard Deviation	56817		
nu star	172.9		
Approximate Chi Square Value (.05)	143.5	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0468	95% CLT UCL	73958
Adjusted Chi Square Value	143	95% Jackknife UCL	74119
		95% Standard Bootstrap UCL	73791

Anderson-Darling Test Statistic	3.173	95% Bootstrap-t UCL	76223
Anderson-Darling 5% Critical Value	0.776	95% Hall's Bootstrap UCL	75550
Kolmogorov-Smirnov Test Statistic	0.191	95% Percentile Bootstrap UCL	73932
Kolmogorov-Smirnov 5% Critical Value	0.106	95% BCA Bootstrap UCL	75168
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	94654
		97.5% Chebyshev(Mean, Sd) UCL	109037
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	137289
95% Approximate Gamma UCL (Use when n >= 40)	74001		
95% Adjusted Gamma UCL (Use when n < 40)	74275		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	94654

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

General UCL Statistics for Data Sets with Non-Detects

User Selected Options	
From File	WorkSheet.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony

General Statistics

Number of Valid Data	56	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	29
Number of Missing Values	53	Percent Non-Detects	51.79%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.26	Minimum Detected	-1.347
Maximum Detected	1430	Maximum Detected	7.265
Mean of Detected	68.75	Mean of Detected	1.441
SD of Detected	274.5	SD of Detected	2.051
Minimum Non-Detect	0.14	Minimum Non-Detect	-1.966
Maximum Non-Detect	3.2	Maximum Non-Detect	1.163
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	43
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	76.79%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.265	Shapiro Wilk Test Statistic	0.923
5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	33.38	Mean	0.149
SD	191.8	SD	1.964
95% DL/2 (t) UCL	76.26	95% H-Stat (DL/2) UCL	21.15
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.826
		SD in Log Scale	2.674
		Mean in Original Scale	33.18
		SD in Original Scale	191.9
		95% t UCL	76.07
		95% Percentile Bootstrap UCL	83.65
		95% BCA Bootstrap UCL	112.6
		95% H-UCL	90.94
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.25	**Data appear Lognormal at 5% Significance Level**	
Theta Star	274.5		
nu star	13.53		

A-D Test Statistic	3.546	**Nonparametric Statistics**	
5% A-D Critical Value	0.873	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.873	Mean	33.32
5% K-S Critical Value	0.184	SD	190.1
Data not Gamma Distributed at 5% Significance Level		SE of Mean	25.89
		95% KM (t) UCL	76.63
Assuming Gamma Distribution		95% KM (z) UCL	75.9
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	76.17
Minimum	0.000001	95% KM (bootstrap t) UCL	433
Maximum	1430	95% KM (BCA) UCL	83.75
Mean	33.15	95% KM (Percentile Bootstrap) UCL	84.49
Median	0.000001	95% KM (Chebyshev) UCL	146.2
SD	191.9	97.5% KM (Chebyshev) UCL	195
k star	0.0908	99% KM (Chebyshev) UCL	290.9
Theta star	365.1		
Nu star	10.17	**Potential UCLs to Use**	
AppChi2	4.047	99% KM (Chebyshev) UCL	290.9
95% Gamma Approximate UCL (Use when n >= 40)	83.27		
95% Adjusted Gamma UCL (Use when n < 40)	85.43		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Data	74	Number of Detected Data	71
Number of Distinct Detected Data	70	Number of Non-Detect Data	3
Number of Missing Values	37	Percent Non-Detects	4.05%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	18.2	Minimum Detected	2.901
Maximum Detected	40000	Maximum Detected	10.6
Mean of Detected	1731	Mean of Detected	5.773
SD of Detected	5958	SD of Detected	1.574
Minimum Non-Detect	4.3	Minimum Non-Detect	1.459
Maximum Non-Detect	23.4	Maximum Non-Detect	3.153
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	69
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	6.76%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.391	Lilliefors Test Statistic	0.0929
5% Lilliefors Critical Value	0.105	5% Lilliefors Critical Value	0.105
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1661	Mean	5.612
SD	5844	SD	1.739
95% DL/2 (t) UCL	2793	95% H-Stat (DL/2) UCL	2324
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1366	Mean in Log Scale	5.624
SD	6054	SD in Log Scale	1.706
95% MLE (t) UCL	2539	Mean in Original Scale	1661
95% MLE (Tiku) UCL	2426	SD in Original Scale	5844
		95% t UCL	2793
		95% Percentile Bootstrap UCL	2864
		95% BCA Bootstrap UCL	3347
		95% H UCL	2180
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.385	**Data appear Lognormal at 5% Significance Level**	
Theta Star	4495		
nu star	54.68		
A-D Test Statistic	6.649	**Nonparametric Statistics**	
5% A-D Critical Value	0.843	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.843	Mean	1661
5% K-S Critical Value	0.114	SD	5804
Data not Gamma Distributed at 5% Significance Level		SE of Mean	679.6
		95% KM (t) UCL	2794
Assuming Gamma Distribution		95% KM (z) UCL	2779
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2793
Minimum	0.000001	95% KM (bootstrap t) UCL	6075
Maximum	40000	95% KM (BCA) UCL	2837
Mean	1661	95% KM (Percentile Bootstrap) UCL	2882
Median	264	95% KM (Chebyshev) UCL	4624
SD	5844	97.5% KM (Chebyshev) UCL	5905
k star	0.283	99% KM (Chebyshev) UCL	8423
Theta star	5871		
Nu star	41.86	**Potential UCLs to Use**	
AppChi2	28.03	97.5% KM (Chebyshev) UCL	5905
95% Gamma Approximate UCL (Use when n >= 40)	2480		
95% Adjusted Gamma UCL (Use when n < 40)	2500		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

BAP Equivalent-Half ND

General Statistics

Number of Valid Data	69	Number of Detected Data	56
Number of Distinct Detected Data	55	Number of Non-Detect Data	13
Number of Missing Values	42	Percent Non-Detects	18.84%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	15	Minimum Detected	2.708
Maximum Detected	5809	Maximum Detected	8.667
Mean of Detected	743	Mean of Detected	6.036
SD of Detected	956.1	SD of Detected	1.143
Minimum Non-Detect	55	Minimum Non-Detect	4.007
Maximum Non-Detect	400	Maximum Non-Detect	5.991
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	40
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	29
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	57.97%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Lilliefors Test Statistic	0.248	Lilliefors Test Statistic	0.105
5% Lilliefors Critical Value	0.118	5% Lilliefors Critical Value	0.118
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	616.4	Mean	5.642
SD	900.1	SD	1.359
95% DL/2 (t) UCL	797.1	95% H-Stat (DL/2) UCL	1012
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	5.665
		SD in Log Scale	1.304
		Mean in Original Scale	615.3
		SD in Original Scale	900.5
		95% t UCL	796.1
		95% Percentile Bootstrap UCL	801
		95% BCA Bootstrap UCL	851.1
		95% H-UCL	942
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.962	**Data appear Lognormal at 5% Significance Level**	
Theta Star	772.2		
nu star	107.8		
A-D Test Statistic	1.004	**Nonparametric Statistics**	
5% A-D Critical Value	0.779	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.779	Mean	612.8
5% K-S Critical Value	0.122	SD	896
Data not Gamma Distributed at 5% Significance Level		SE of Mean	108.9
		95% KM (t) UCL	794.4
Assuming Gamma Distribution		95% KM (z) UCL	791.9
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	794.1
Minimum	0.000001	95% KM (bootstrap t) UCL	879.4
Maximum	5809	95% KM (BCA) UCL	796.8
Mean	603	95% KM (Percentile Bootstrap) UCL	802.3
Median	311.3	95% KM (Chebyshev) UCL	1087
SD	908.3	97.5% KM (Chebyshev) UCL	1293
k star	0.184	99% KM (Chebyshev) UCL	1696

Theta star	3284		
Nu star	25.34	**Potential UCLs to Use**	
AppChi2	14.87	95% KM (Chebyshev) UCL	1087
95% Gamma Approximate UCL (Use when n >= 40)	1027		
95% Adjusted Gamma UCL (Use when n < 40)	1039		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

ATTACHMENT 2

EXAMPLE CALCULATIONS

Example Calculation - BAP TEQ
Units = ug/kg
Sample = TP-SB14-0709-98

Sample Results	
Chemical	**Concentration (with qualifier)**
BENZO(A)ANTHRACENE	620 J
BENZO(A)PYRENE	3100 J
BENZO(B)FLUORANTHENE	1300 J
BENZO(K)FLUORANTHENE	530 UJ
CHRYSENE	760 J
DIBENZO(A,H)ANTHRACENE	530 UJ
INDENO(1,2,3-CD)PYRENE	1300 J

Assumptions:
- Positive results accepted
- Non-detected results are assumed to be 1/2 quantitation limit
- Rejected results (R) are not used
- If all individual carcinogenic PAHs are non-detected, BAP TEQ = the quantitation limit for BAP

BAP TEQ $= \Sigma(\text{Sample Result}_{\text{chemical 1}} \times \text{TEF}_{\text{chemical 1}} + \text{Sample Result}_{\text{chemical 2}} \times \text{TEF}_{\text{chemical 2}} \ldots)$

$= 0.1 \times 620 + 1 \times 3100 + 0.1 \times 1300 + 0.01 \times 265 + 0.001 \times 760 + 1 \times 265 + 0.1 \times 1300$

$=$ **3690 ug/kg**

Used in Calculation:

Carcinogenic PAH	TEF	Concentration
BENZO(A)ANTHRACENE	0.1	620
BENZO(A)PYRENE	1	3100
BENZO(B)FLUORANTHENE	0.1	1300
BENZO(K)FLUORANTHENE	0.01	265
CHRYSENE	0.001	760
DIBENZO(A,H)ANTHRACENE	1	265
INDENO(1,2,3-CD)PYRENE	0.1	1300

BAP = Benzo(a)pyrene
TEF = Toxicity Equivalence Factor

Example Calculation - 2,3,7,8-TCDD TEQ
Units = ng/kg
Sample = TPSB270205

Sample Results	
Chemical	**Concentration (with qualifier)**
1,2,3,4,6,7,8,9-OCDD	278 J
1,2,3,4,6,7,8,9-OCDF	562 J
1,2,3,4,6,7,8-HPCDD	12.5
1,2,3,4,6,7,8-HPCDF	538
1,2,3,4,7,8,9-HPCDF	267
1,2,3,4,7,8-HXCDD	1.4 U
1,2,3,4,7,8-HXCDF	1690
1,2,3,6,7,8-HXCDD	4.9 J
1,2,3,6,7,8-HXCDF	533
1,2,3,7,8,9-HXCDD	1.4 U
1,2,3,7,8,9-HXCDF	521 J
1,2,3,7,8-PECDD	1.6 U
1,2,3,7,8-PECDF	5050
2,3,4,6,7,8-HXCDF	549
2,3,4,7,8-PECDF	2240
2,3,7,8-TCDD	0.8 U
2,3,7,8-TCDF	5210

Used in Calculation:

Dioxins/Furans	TEF	Concentration
1,2,3,4,6,7,8,9-OCDD	0.0003	278
1,2,3,4,6,7,8,9-OCDF	0.0003	562
1,2,3,4,6,7,8-HPCDD	0.01	12.5
1,2,3,4,6,7,8-HPCDF	0.01	538
1,2,3,4,7,8,9-HPCDF	0.01	267
1,2,3,4,7,8-HXCDD	0.1	0.7
1,2,3,4,7,8-HXCDF	0.1	1690
1,2,3,6,7,8-HXCDD	0.1	4.9
1,2,3,6,7,8-HXCDF	0.1	533
1,2,3,7,8,9-HXCDD	0.1	0.7
1,2,3,7,8,9-HXCDF	0.1	521
1,2,3,7,8-PECDD	1	0.8
1,2,3,7,8-PECDF	0.03	5050
2,3,4,6,7,8-HXCDF	0.1	549
2,3,4,7,8-PECDF	0.3	2240
2,3,7,8-TCDD	1	0.4
2,3,7,8-TCDF	0.1	5210

TEF = Toxicity Equivalence Factor
TEF Source = WHO, 2006.
TEQ = Toxicity Equivalency Quotient

Assumptions:
- Positive results accepted
- Non-detected results are assumed to be 1/2 quantitation limit
- Rejected results (R) are not used
- If all individual dioxins/furans are non-detected, TCDD TEQ = the quantitation limit for 2,3,7,8-TCDD

$$\text{2,3,7,8-TCDD TEQ} = \Sigma(\text{Sample Result}_{\text{chemical 1}} \times \text{TEF}_{\text{chemical 1}} + \text{Sample Result}_{\text{chemical 2}} \times \text{TEF}_{\text{chemical 2}} \ldots)$$

$$= 278 \times 0.0003 + 562 \times 0.0003 \ldots.$$

$$= \quad 1684 \quad \text{ng/kg}$$

Example Calculation - Total PCBs
Units = ug/kg
Sample = TP-SB14-0305-98

Sample Results	
Chemical	**Concentration (with qualifier)**
Aroclor-1016	680 U
Aroclor-1221	1400 U
Aroclor-1232	680 U
Aroclor-1242	680 U
Aroclor-1248	680 U
Aroclor-1254	680 U
Aroclor-1260	42000

Used in Calculation:

Chemical	Concentration
Aroclor-1016	340
Aroclor-1221	700
Aroclor-1232	340
Aroclor-1242	340
Aroclor-1248	340
Aroclor-1254	340
Aroclor-1260	42000

Assumptions:
- Positive results accepted
- Non-detected results are assumed to be 1/2 quantitation limit
- Rejected results (R) are not used

Total PCB Aroclors = Σ(Sample Result$_{\text{chemical 1}}$ + Sample Result$_{\text{chemical 2}}$...)

= (7.1 + 0.3...) x 2

= 44400 ug/kg

APPENDIX B

ALTERNATIVE-SPECIFIC ARARs

TABLE B-1

ALTERNATIVE 1: NO ACTION
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
FEDERAL CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12	To be considered (TBC)	United States Environmental Protection Agency (USEPA) has provided recommended methodology for assessing risk caused by exposure to lead in surface soil under residential scenarios.	Guidelines were used to develop risk-based cleanup goals for lead in soil.
	USEPA Risk Reference Doses (RfDs) from Integrated Risk Information System (IRIS)	TBC	RfDs are estimates of daily exposure for human populations (including sensitive subpopulations) considered unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure over a lifetime.	RfDs were used to develop risk-based soil cleanup goals for non-carcinogenic contaminants of concern (COCs), including antimony, copper, dioxins/furans, and iron.
	USEPA Human Health Assessment Group Cancer Slope Factors (CSFs) from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic COCs, including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform Human Health Risk Assessment (HHRA). They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.

TABLE B-1

ALTERNATIVE 1: NO ACTION
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU7 instead of RAGs table values.
FEDERAL LOCATION-SPECIFIC ARARs and TBCs : No ARARs or TBCs				
STATE LOCATION-SPECIFIC ARARs and TBCs: No ARARs or TBCs				
FEDERAL ACTION-SPECIFIC ARARs and TBCs: No ARARs or TBCs				
STATE ACTION-SPECIFIC ARARs and TBCs: No ARARs or TBCs				

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
FEDERAL CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12	To be considered (TBC)	USEPA has provided recommended methodology for assessing risk caused by exposure to lead in surface soil under residential scenarios.	Guidelines were used to develop risk-based cleanup goals for lead in soil.
	USEPA Risk Reference Doses (RfDs) from Integrated Risk Information System (IRIS)	TBC	RfDs are estimates of daily exposure for human populations (including sensitive subpopulations) considered unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure over a lifetime.	RfDs were used to develop risk-based soil cleanup goals for non-carcinogenic chemicals of concern (COCs), including antimony, copper, dioxins/furans, and iron.
	USEPA Human Health Assessment Group Cancer Slope Factors (CSFs) from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic COCs, including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform Human Health Risk Assessment (HHRA). They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.

TABLE B-2

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU7 instead of RAGs table values.
FEDERAL LOCATION-SPECIFIC ARARs and TBCs				
Coastal Zone Management	Coastal Zone Management Act [16 United States Code (USC) 1451 *et seq*]	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Remedial activities related to shoreline control maintenance, that take place in the coastal zone would be controlled according to the requirements of the Maine Department of Environmental Protection (MEDEP) program. MEDEP would review plans to ensure that they meet the substantive requirements of this act. The requirements of the act would continue to apply during the operation and maintenance of the remedy.
Wetlands and US Waters	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material [40 Code of Federal Regulations (CFR) 230; 33 CFR 320, 322, and 323]	Applicable	These regulations outline the requirements for the discharge of dredged or fill material into US waters, including wetlands. No activity that adversely affects a US waters is permitted if a practicable alternative that has less effect is available. If there is no other practicable alternative, impacts must be mitigated.	Remedial activities related to shoreline control maintenance would be performed so as to not impact the offshore area.

TABLE B-2

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq.*; 50 CFR Parts 17 and 402)	Applicable	Provides for consideration of the impacts on endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon is listed as a threatened species.	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However short-nosed and Atlantic sturgeon are present in the Piscataqua River. Remedial activities would be conducted so as to avoid any adverse effect under the act to these sturgeon.
	Fish and Wildlife Coordination Act (16 USC 661 *et seq.*)	Applicable	This act requires any federal agency proposing to modify a body of water to coordinate with the United States Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) and appropriate state agencies if alteration of a body of water, including discharge of pollutants into a wetland or construction in a wetland, will occur as a result of offsite remedial activities.	For remedial activities related to shoreline control maintenance that may impact the coastal floodplain and river, the Navy would coordinate with USFWS in the event that the remedy disturbs these areas.
Floodplain Management and Protection of Wetlands	44 CFR 9	Relevant and Appropriate	Federal Emergency Management Agency (FEMA) regulations that set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Remedial activities conducted within the 100-year floodplain of the Piscataqua River or federal jurisdictional wetlands would be implemented in compliance with these standards.

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE LOCATION-SPECIFIC ARARs and TBCs				
Other Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 Maine Revised Statutes Annotated (MRSA) 480 *et seq.*; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream or brook.	Remedial activities related to shoreline control maintenance would be conducted so as to avoid washing any soil into the nearby Piscataqua River or adjacent wetlands. Stormwater management and erosion control practices would be used to prevent soil from entering the river or adjacent wetlands during remedial activities.
Wetlands	Maine Wetland Protection Rules(06-096 CMR Part 310)	Applicable	Standards are provided for protection of wetlands, as defined in MEDEP Ch. 1000 Guidelines for Municipal Shoreline Zoning Ordinances. Jurisdiction under the Rules includes the area adjacent to the wetlands, which is the area within 75 feet of the normal high water line. Activities that have an unreasonable impact on wetlands are prohibited.	Remedial activities related to shoreline control maintenance would be conducted to avoid impacts to wetlands and coastal wetlands, which include tidal and subtidal lands.

TABLE B-2

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq*.) (06-096 CMR chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the high-water line of a stream.	Remedial activities, related to shoreline control and maintenance that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.
FEDERAL ACTION-SPECIFIC ARARs and TBCs				
Surface Water	CWA [33 USC § 1251 *et seq.*]; National Recommended Water Quality Criteria (NRWQC) (40 CFR Part 122.44)	Relevant and Appropriate	These criteria are used to establish water quality standards for the protection of aquatic life.	Remedial activities would be conducted to reduce adverse impacts to the Piscataqua River. Stormwater management and erosion control practices would be used to prevent soil and contamination from entering the river during maintenance of shoreline controls.

TABLE B-2

ALTERNATIVE 2: LAND USE CONTROLS AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE ACTION-SPECIFIC ARARs and TBCs				
Hazardous Waste	Identification of Hazardous Wastes 06-096 Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing. Wastes with PCB concentrations greater than or equal to 50 ppm are hazardous wastes in Maine.	Wastes generated during maintenance of shoreline controls would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste (38 MRSA 1301 *et seq.*, 06-096 Part 851)	Applicable	These regulations contain requirements for the generators of hazardous waste.	Wastes generated during maintenance of shoreline controls that are determined to be hazardous waste would be managed in accordance with regulatory requirements.
Erosion	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to remedial activities that need to address erosion and sedimentation. Applicable plans would be coordinated with MEDEP before implementation.
Waste Management	Additional Standards Applicable to Waste Facilities Located in a Flood Plain (06-096 CMR 854.16)	Relevant and Appropriate	Any facility located or to be located within 300 feet of a 100 year flood zone must be constructed, operated, and maintained to prevent wash-out of any hazardous waste by a 100 year flood or have procedures in place which will cause the waste to be removed to a location where the waste will not be vulnerable to flood waters and to a location which is authorized to manage hazardous waste safely before flood water can reach the facility.	Any remedial activities conducted within 300 feet of the 100-year flood zone would be conducted in compliance with these standards.

TABLE B-3

ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LAND USE CONTROLS, AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
FEDERAL CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12	To be considered (TBC)	USEPA has provided recommended methodology for assessing risk caused by exposure to lead in surface soil under residential scenarios.	Guidelines were used to develop risk-based cleanup goals for lead in soil.
	USEPA Risk Reference Doses (RfDs) from Integrated Risk Information System (IRIS)	TBC	RfDs are estimates of daily exposure for human populations (including sensitive subpopulations) considered unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure over a lifetime.	RfDs were used to develop risk-based soil cleanup goals for non-carcinogenic COCs, including antimony, copper, dioxins/furans, and iron.
	USEPA Human Health Assessment Group Cancer Slope Factors (CSFs) from IRIS	TBC	CSFs present the most up-to-date information on cancer risk potency for known and suspected carcinogens.	CSFs were used to develop risk-based soil cleanup goals for carcinogenic COCs, including polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).
	Guidelines for Carcinogen Risk Assessment EPA/630/P-03/001F (2005a)	TBC	These guidelines are used to perform Human Health Risk Assessment (HHRA). They provide a framework for assessing possible cancer risks from exposures to pollutants or other agents in the environment.	These guidelines were used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.
	Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens EPA/630/R-03/003F (2005b)	TBC	These guidelines are used to perform HHRA and address a number of issues pertaining to cancer risks associated with early-life exposures in general and provide specific guidance on potency adjustment for carcinogens acting through a mutagenic mode of action.	This guidance was used to develop risk-based soil cleanup goals for carcinogenic COCs, including PCBs and PAHs.

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE CHEMICAL-SPECIFIC ARARs and TBCs				
Soil/Risk Assessment	Maine Remedial Action Guidelines (RAGs) for Soil Contaminated with Hazardous Substances (Section V.H) (MEDEP, 2010)	TBC	Maine RAGs provide procedures to determine soil cleanup levels unless site-specific risk-based cleanup levels are calculated. Chemical-specific guidelines that may assist in making remedial decisions are also provided. Guidelines are presented for four exposure scenarios.	Per Section V.H, site-specific risk-based cleanup levels were used for OU7 instead of RAGs table values.
FEDERAL LOCATION-SPECIFIC ARARs and TBCs				
Coastal Zone Management	Coastal Zone Management Act [16 United States Code (USC) 1451 *et seq*]	Applicable	This act provides for the preservation and protection of coastal zone areas. Federal activities that are in or directly affecting the coastal zone must be consistent, to the maximum extent practicable, with a federally approved state management program.	Remedial activities related to shoreline control maintenance that take place in the coastal zone would be controlled according to the requirements of the MEDEP program. MEDEP would review the remedial action document and work plans to ensure that they meet the substantive requirements of this act. The requirements of the act would continue to apply during the operation and maintenance of the remedy.
Wetlands and US Waters	Clean Water Act (CWA) Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material [40 Code of Federal Regulations (CFR) 230; 33 CFR 320, 322, and 323]	Applicable	These regulations outline the requirements for the discharge of dredged or fill material into US waters, including wetlands. No activity that adversely affects a US waters is permitted if a practicable alternative that has less effect is available. If there is no other practicable alternative, impacts must be mitigated.	Remedial activities related to shoreline control maintenance would be performed so as to not impact the offshore area.

ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LAND USE CONTROLS, AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Other Natural Resources	The Endangered Species Act of 1973 (16 USC 1531 *et seq.*; 50 CFR Parts 17 and 402)	Applicable	Provides for consideration of the impacts on endangered and threatened species and their critical habitats. Requires federal agencies to ensure that any action carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. The entire state of Maine is considered a habitat of the federally-listed endangered short-nosed sturgeon. The Gulf of Maine population of Atlantic sturgeon is listed as a threatened species.	There are no known endangered, threatened, or protected species or critical habitats within the boundaries of PNS. However short-nosed and Atlantic sturgeon are present in the Piscataqua River. Remedial activities would be conducted so as to avoid any adverse effect under the act to these sturgeon.
	Fish and Wildlife Coordination Act (16 USC 661 *et seq.*)	Applicable	This act requires any federal agency proposing to modify a body of water to coordinate with the United States Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) and appropriate state agencies if alteration of a body of water, including discharge of pollutants into a wetland or construction in a wetland, will occur as a result of offsite remedial activities.	For remedial activities related to shoreline control maintenance that may impact the coastal floodplain and river, the Navy would coordinate with USFWS in the event that the remedy disturbs these areas.
Floodplain Management and Protection of Wetlands	44 CFR 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure, and responsibilities to implement and enforce Executive Order 11988, Floodplain Management, and Executive Order 11990, Protection of Wetlands.	Remedial activities conducted within the 100-year floodplain of the Piscataqua River or federal jurisdictional wetlands would be implemented in compliance with these standards.

TABLE B-3

ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LAND USE CONTROLS, AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE LOCATION-SPECIFIC ARARs and TBCs				
Other Natural Resources	Maine Natural Resources Protection Act Permit by Rule Standards [38 Maine Revised Statutes Annotated (MRSA) 480 *et seq.*; 06-096 Code of Maine Rules (CMR) Part 305, 1, 2, and 8]	Applicable	This act regulates activity conducted in, on, or over any protected natural resource or any activity conducted adjacent to and operated in such a way that material or soil may be washed into any freshwater or coastal wetland, great pond, river, stream or brook.	Remedial activities related to shoreline control maintenance would be conducted so as to avoid washing any soil into the nearby Piscataqua River or adjacent wetlands. Stormwater management and erosion control practices would be used to prevent sediment from entering the river or adjacent wetlands during remedial activities.
Wetlands	Maine Wetland Protection Rules(06-096 CMR Part 310)	Applicable	Standards are provided for protection of wetlands, as defined in MEDEP Ch. 1000 Guidelines for Municipal Shoreline Zoning Ordinances. Jurisdiction under the Rules includes the area adjacent to the wetlands, which is the area within 75 feet of the normal high water line. Activities that have an unreasonable impact on wetlands are prohibited.	Remedial activities related to shoreline control maintenance would be conducted to avoid impacts to wetlands and coastal wetlands, which include tidal and subtidal lands.

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Coastal Zone	Maine Coastal Management Policies (38 MRSA 1801 *et seq*.) (06-096 CMR chapter 1000)	Applicable	Regulates activities near great ponds, rivers and larger streams, coastal areas, and wetlands. Regulates shoreland activities and development, including (but not limited to) water pollution prevention and control, wildlife habitat protection, and freshwater and coastal wetlands protection. The law is administered at the local government level. Shoreland areas include areas within 250 feet of the normal high-water line of any river or saltwater body and areas within 75 feet of the high-water line of a stream.	Remedial activities related to shoreline control maintenance that may affect storm water runoff, erosion and sedimentation, and surface water quality would be controlled according to these regulations.
FEDERAL ACTION-SPECIFIC ARARs and TBCs				
Surface Water	CWA [33 USC § 1251 *et seq.*]; National Recommended Water Quality Criteria (NRWQC) (40 CFR Part 122.44)	Relevant and Appropriate	These criteria are used to establish water quality standards for the protection of aquatic life.	Remedial activities would be conducted to reduce adverse impacts to the Piscataqua River. Stormwater management and erosion control practices would be used to prevent soil and contamination from entering the river during maintenance of shoreline controls.
Water Management	CWA Section 402 National Pollutant Discharge Elimination System (NPDES) (40 CFR, 22, 26)	Applicable	CWA Section 402 requires NPDES permits for stormwater discharges to navigable waters.	Stormwater management would be implemented to minimize discharges of contaminants to the Piscataqua River and meet the substantive requirements of this act.

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
STATE ACTION-SPECIFIC ARARs and TBCs				
Hazardous Waste	Identification of Hazardous Wastes 06-096 Part 850	Applicable	These standards establish requirements for determining whether wastes are hazardous based on either characteristic or listing. Wastes with PCB concentrations greater than or equal to 50 ppm are hazardous wastes in Maine.	Wastes generated during remedial activities would be analyzed to determine whether they are RCRA characteristic hazardous wastes. If determined to be hazardous, then the waste would be managed in accordance with regulatory requirements.
	Standards for Generators of Hazardous Waste (38 MRSA 1301 *et seq.*, 06-096 Part 851)	Applicable	These regulations contain requirements for the generators of hazardous waste.	Wastes generated during remedial activities that are determined to be hazardous waste would be managed in accordance with regulatory requirements.
Water Management	Maine Discharge Licenses (38 MRSA 413 *et seq.*) and Waste Discharge Permitting Program (06-096 CMR 520-629)	Applicable	These standards regulate the discharge of pollutants from point sources.	These regulations area applicable to water management during soil excavation and discharges of treat water to a surface water body, if required. The substantive requirements would be met if any discharges of treated water to surface water bodies are required during the remedial action.
Erosion	Erosion and Sedimentation Control (38 MRSA Part 420-C)	Applicable	Erosion control measures must be in place before activities such as filling, displacing, or exposing soil or other earthen materials occur. Prior MEDEP approval is required if the disturbed area is in the direct watershed of a body of water most at risk for erosion or sedimentation.	These controls would be applicable to remedial activities that need to address erosion and sedimentation. Applicable plans would be coordinated with MEDEP before implementation.

TABLE B-3

ALTERNATIVE 3: LIMITED EXCAVATION IN FORMER TIMBER BASIN AREA, RESIDENTIAL LAND USE CONTROLS, AND LONG-TERM MANAGEMENT OF SHORELINE CONTROLS
CHEMICAL, LOCATION AND ACTION-SPECIFIC ARARs
OPERABLE UNIT 7 - FEASIBILITY STUDY REPORT
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Waste Management	Additional Standards Applicable to Waste Facilities Located in a Flood Plain (06-096 CMR 854.16)	Relevant and Appropriate	Any facility located or to be located within 300 feet of a 100 year flood zone must be constructed, operated, and maintained to prevent wash-out of any hazardous waste by a 100 year flood or have procedures in place which will cause the waste to be removed to a location where the waste will not be vulnerable to flood waters and to a location which is authorized to manage hazardous waste safely before flood water can reach the facility.	Any remedial activities conducted within 300 feet of the 100-year flood zone would be conducted in compliance with these standards.
Air Emissions	Visible Emissions Regulation (38 MRSA Part 584; 06-096 CMR Part 101)	TBC	These regulations establish opacity limits for emissions from several categories of air contaminant sources, including general fugitive emissions.	These regulations would be considered for excavation and backfilling activities. These standards would be met if any of the activities result in emission of particulate matter and fugitive matter to the atmosphere (e.g., dust generation).

APPENDIX C

COST ESTIMATES

APPENDIX C.1

COST ESTIMATES FOR POTENTIAL ALTERNATIVES ELIMINATED DUE TO COSTS

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Complete Site Excavation to 5 Feet Below Ground
Capital Cost

5/17/2012 9:32 AM

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
COMPLETE EXCAVATION AND DISPOSAL											
Temporary Fence	2,400	lf	$8.65				$20,760	$0	$0	$0	$20,760
Excavator, 2.5 cy (2 each)	450	day			$362.80	$1,613.00	$0	$0	$163,260	$725,850	$889,110
Pavement Saw, 18 hp	450	day				$63.20	$0	$0	$0	$28,440	$28,440
Sliding Rail Shoring (50' by 10' by 9' deep) 10 days	1	ls	$43,650.00				$43,650	$0	$0	$0	$43,650
Site Labor, (3 laborers)	450	day			$274.80		$0	$0	$123,660	$0	$123,660
Confirmation Sampling, lead	20	ea	$50.00	$30.00	$50.00	$30.00	$1,000	$600	$1,000	$600	$3,200
Confirmation Sampling, dioxin/furan	20	ea	$1,200.00	$30.00	$50.00	$30.00	$24,000	$600	$1,000	$600	$26,200
Confirmation Sampling, PCBs	20	ea	$160.00	$30.00	$50.00	$30.00	$3,200	$600	$1,000	$600	$5,400
T & D of Excavated Soil, hazardous	0	ton	$245.00				$0	$0	$0	$0	$0
T & D of Excavated Soil, non-hazardous	200,000	ton	$80.00				$16,000,000	$0	$0	$0	$16,000,000
T & D of Demo Materials	20	ton	$55.00				$1,100	$0	$0	$0	$1,100
Waste Disposal Characterization / Analytical	10	ea	$850.00	$30.00	$50.00	$30.00	$8,500	$300	$500	$300	$9,600
											$17,151,120

* Only excavation and disposal costs are shown to demonstrate the high costs for this screened out alternative. Actual costs for this alternative would be higher than shown.

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Complete Shoreline Contamination Removal
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 MOBILIZATION AND DEMOBILIZATION											
1.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
1.2 Equipment Mobilization/Demobilization	7	ea			$183.00	$518.00	$0	$0	$1,281	$3,626	$4,907
2 FIELD SUPPORT AND SITE ACCESS											
2.1 Office Trailer	4	mo				$360.00	$0	$0	$0	$1,440	$1,440
2.2 Field Office Equipment, Utilities, & Support	4	mo		$519.00			$0	$2,076	$0	$0	$2,076
2.3 Storage Trailer	4	mo				$94.00	$0	$0	$0	$376	$376
2.4 Survey Support	10	day	$1,125.00				$11,250	$0	$0	$0	$11,250
2.5 Site Superintendent	85	day		$153.00	$420.00		$0	$13,005	$35,700	$0	$48,705
2.6 Site Health & Safety and QA/QC	85	day		$153.00	$370.00		$0	$13,005	$31,450	$0	$44,455
2.7 Underground Utility Clearance	1	ls	$9,500.00				$9,500	$0	$0	$0	$9,500
3 DECONTAMINATION											
3.1 Decontamination Services	2	mo		$1,220.00	$2,245.00	$1,550.00	$0	$2,440	$4,490	$3,100	$10,030
3.2 Equipment Decon Pad	1	ls		$4,500.00	$3,000.00	$725.00	$0	$4,500	$3,000	$725	$8,225
3.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
3.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$780.00	$0	$0	$0	$1,560	$1,560
3.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$702.00	$0	$0	$0	$1,404	$1,404
3.6 Disposal of Decon Waste (liquid & solid)	2	mo	$985.00				$1,970	$0	$0	$0	$1,970
4 SHORELINE EXCAVATION AND DISPOSAL											
4.1 Temporary Fence	1,400	lf	$8.65				$12,110	$0	$0	$0	$12,110
4.2 Excavator, 2.5 cy	30	day			$362.80	$1,613.00	$0	$0	$10,884	$48,390	$59,274
4.3 Gradall, 1 cy	30	day			$362.80	$1,001.00	$0	$0	$10,884	$30,030	$40,914
4.4 Front End Loader, 185 hp	30	day			$362.80	$598.60	$0	$0	$10,884	$17,958	$28,842
4.5 Pavement Saw, 18 hp	4	day				$63.20	$0	$0	$0	$253	$253
4.6 Site Labor, (3 laborers)	90	day			$274.80		$0	$0	$24,732	$0	$24,732

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Complete Shoreline Contamination Removal
Capital Cost

	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
4.7	T & D of Excavated Soil, non-hazardous	2,823	ton	$80.00				$225,840	$0	$0	$0	$225,840
4.8	T & D of Excavated Soil, hazardous	2,823	ton	$245.00				$691,635	$0	$0	$0	$691,635
4.9	T & D of Demo Materials	40	ton	$55.00				$2,200	$0	$0	$0	$2,200
4.10	Waste Disposal Characterization / Analytical	8	ea	$850.00	$30.00	$50.00	$30.00	$6,800	$240	$400	$240	$7,680
5	**SHORELINE RESTORATION**											
5.1	Backfill, gravel	326	cy		$39.50			$0	$12,877	$0	$0	$12,877
5.2	Geotextile Fabric	5,930	sy		$1.48			$0	$8,776	$0	$0	$8,776
5.3	Stone, #57	112	cy		$27.80			$0	$3,114	$0	$0	$3,114
5.4	Riprap	54	cy		$31.50			$0	$1,701	$0	$0	$1,701
5.5	Excavator, 2.5 cy	20	day			$362.80	$1,613.00	$0	$0	$7,256	$32,260	$39,516
5.6	Gradall, 1 cy	20	day			$362.80	$1,001.00	$0	$0	$7,256	$20,020	$27,276
5.7	Front End Loader, 185 hp	20	day			$362.80	$598.60	$0	$0	$7,256	$11,972	$19,228
5.8	Site Labor, (3 laborers)	60	day			$274.80		$0	$0	$16,488	$0	$16,488
5.9	Pavement Repair (6" base, 2" binder, 1" top)	6,960	sf	$2.62				$18,235	$0	$0	$0	$18,235
6	**POST CONSTRUCTION COST**											
6.1	Contractor Completion Report	150	hr			$39.00		$0	$0	$5,850	$0	$5,850
6.2	Remedial Action Closeout Report	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
	Subtotal							$979,540	$63,134	$211,351	$176,854	$1,430,879
	Overhead on Labor Cost @ 30%									$63,405		$63,405
	G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$97,954	$6,313	$21,135	$17,685	$143,088
	Tax on Materials and Equipment Cost @ 6%								$3,788		$10,611	$14,399
	Total Direct Cost							$1,077,494	$73,235	$295,891	$205,150	$1,651,771
	Indirects on Total Direct Cost @ 30%	(excluding transportation and disposal cost)										$219,038
	Profit on Total Direct Cost @ 10%											$165,177
	Subtotal											$2,035,987
	Health & Safety Monitoring @ 2%											$40,720
	Total Field Cost											$2,076,706
	Contingency on Total Field Costs @ 20%											$415,341
	Engineering on Total Field Cost @ 8%											$166,137
	TOTAL CAPITAL COST											**$2,658,184**

APPENDIX C.2

COST ESTIMATES FOR DEVELOPED ALTERNATIVES

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 2 - Land Use Controls and Long-Term Management of Shoreline Controls
Capital Cost

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	Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1	**PROJECT PLANNING & DOCUMENTS**											
1.1	Prepare LUC Documents	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
	Subtotal							$0	$0	$7,800	$0	$7,800
	Overhead on Labor Cost @	30%								$2,340		$2,340
	G & A on Labor, Material, Equipment, & Subs Cost @	10%						$0	$0	$780	$0	$780
	Tax on Materials and Equipment Cost @	6%							$0		$0	$0
	Total Direct Cost							$0	$0	$10,920	$0	$10,920
	Indirects on Total Direct Cost @	0%										$0
	Profit on Total Direct Cost @	10%										$1,092
	Subtotal											$12,012
	Health & Safety Monitoring @	0%										$0
	Total Field Cost											$12,012
	Contingency on Total Field Costs @	25%										$3,003
	Engineering on Total Field Cost @	0%										$0
	TOTAL CAPITAL COST											**$15,015**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 2 - Land Use Controls and Long-Term Management of Shoreline Controls
Shoreline Maintenance Years 15 and 30

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 MOBILIZATION AND DEMOBILIZATION											
1.2 Equipment Mobilization/Demobilization	3	ea			$188.00	$566.00	$0	$0	$564	$1,698	$2,262
2 FIELD SUPPORT AND SITE ACCESS											
2.1 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
2.2 Survey Support	1	day	$1,150.00				$1,150	$0	$0	$0	$1,150
2.3 Site Superintendent	5	day		$153.00	$420.00		$0	$765	$2,100	$0	$2,865
3 SHORELINE MAINTENANCE											
3.1 Backfill, gravel	82	cy		$41.00			$0	$3,362	$0	$0	$3,362
3.2 Riprap	14	cy		$31.50			$0	$441	$0	$0	$441
3.3 Excavator, 2.5 cy long reach	5	day			$382.40	$2,312.80	$0	$0	$1,912	$11,564	$13,476
3.4 Front End Loader, 185 hp	5	day			$382.40	$611.00	$0	$0	$1,912	$3,055	$4,967
3.5 Site Labor, (3 laborers)	15	day			$280.80		$0	$0	$4,212	$0	$4,212
4 POST CONSTRUCTION COST											
4.1 Contractor Completion Report	80	hr			$39.00		$0	$0	$3,120	$0	$3,120
Subtotal							$1,150	$4,568	$39,560	$16,411	$61,689
Overhead on Labor Cost @ 30%									$11,868		$11,868
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$115	$457	$3,956	$1,641	$6,169
Tax on Materials and Equipment Cost @ 6%								$274		$985	$1,259
Total Direct Cost							$1,265	$5,299	$55,384	$19,037	$80,985
Indirects on Total Direct Cost @ 20%											$16,197
Profit on Total Direct Cost @ 10%											$8,098
Subtotal											$105,280
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$105,280
Contingency on Total Field Costs @ 20%											$21,056
Engineering on Total Field Cost @ 15%											$15,792
TOTAL CAPITAL COST											**$142,128**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 2 - Land Use Controls and Long-Term Management of Shoreline Controls
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Annual Site Inspection & Report	$2,950		Labor and supplies once a year to inspect Land Use Controls with Report.
Five Year Site Review		$23,000	Labor and supplies to evaluate site every five years for 5-year review
SUBTOTAL	$2,950	$23,000	
Contingency @ 10%	$295	$2,300	
TOTAL	**$3,245**	**$25,300**	

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 2 - Land Use Controls and Long-Term Management of Shoreline Controls
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$15,015		$15,015	1.000	$15,015
1		$3,245	$3,245	0.980	$3,181
2		$3,245	$3,245	0.961	$3,119
3		$3,245	$3,245	0.942	$3,058
4		$3,245	$3,245	0.924	$2,998
5		$28,545	$28,545	0.906	$25,854
6		$3,245	$3,245	0.888	$2,881
7		$3,245	$3,245	0.871	$2,825
8		$3,245	$3,245	0.853	$2,770
9		$3,245	$3,245	0.837	$2,715
10		$28,545	$28,545	0.820	$23,417
11		$3,245	$3,245	0.804	$2,610
12		$3,245	$3,245	0.788	$2,559
13		$3,245	$3,245	0.773	$2,508
14		$3,245	$3,245	0.758	$2,459
15	$142,128	$28,545	$170,673	0.743	$126,813
16		$3,245	$3,245	0.728	$2,364
17		$3,245	$3,245	0.714	$2,317
18		$3,245	$3,245	0.700	$2,272
19		$3,245	$3,245	0.686	$2,227
20		$28,545	$28,545	0.673	$19,210
21		$3,245	$3,245	0.660	$2,141
22		$3,245	$3,245	0.647	$2,099
23		$3,245	$3,245	0.634	$2,058
24		$3,245	$3,245	0.622	$2,017
25		$28,545	$28,545	0.610	$17,399
26		$3,245	$3,245	0.598	$1,939
27		$3,245	$3,245	0.586	$1,901
28		$3,245	$3,245	0.574	$1,864
29		$3,245	$3,245	0.563	$1,827
30	$142,128	$28,545	$170,673	0.552	$94,224
				TOTAL PRESENT WORTH	**$380,642**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 3 - Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shoreline Controls
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare LUC Documents	200	hr			$39.00		$0	$0	$7,800	$0	$7,800
1.2 Prepare Documents & Plans including Permits	300	hr			$39.00		$0	$0	$11,700	$0	$11,700
2 MOBILIZATION AND DEMOBILIZATION											
2.1 Site Support Facilities (trailers, phone, electric, etc.)	1	ls		$1,000.00		$3,500.00	$0	$1,000	$0	$3,500	$4,500
2.2 Equipment Mobilization/Demobilization	3	ea			$188.00	$566.00	$0	$0	$564	$1,698	$2,262
3 FIELD SUPPORT AND SITE ACCESS											
3.1 Office Trailer	1	mo				$365.00	$0	$0	$0	$365	$365
3.2 Field Office Equipment, Utilities, & Support	1	mo		$508.00			$0	$508	$0	$0	$508
3.3 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
3.4 Survey Support	3	day	$1,150.00				$3,450	$0	$0	$0	$3,450
3.5 Site Superintendent	25	day		$153.00	$420.00		$0	$3,825	$10,500	$0	$14,325
3.6 Site Health & Safety and QA/QC	25	day		$153.00	$370.00		$0	$3,825	$9,250	$0	$13,075
3.7 Underground Utility Clearance	1	ls	$9,500.00				$9,500	$0	$0	$0	$9,500
4 DECONTAMINATION											
4.1 Decontamination Services	1	mo		$1,220.00	$2,345.00	$1,550.00	$0	$1,220	$2,345	$1,550	$5,115
4.2 Equipment Decon Pad	1	ls		$4,500.00	$3,200.00	$725.00	$0	$4,500	$3,200	$725	$8,425
4.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
4.4 Decon Water Storage Tank, 6,000 gallon	1	mo				$813.00	$0	$0	$0	$813	$813
4.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$731.00	$0	$0	$0	$731	$731
4.6 Disposal of Decon Waste (liquid & solid)	1	mo	$995.00				$995	$0	$0	$0	$995
5 AREAS 1 and 2 EXCAVATION AND DISPOSAL											
5.1 Temporary Fence	300	lf	$8.75				$2,625	$0	$0	$0	$2,625
5.2 Excavator, 2 cy	10	day			$382.40	$1,253.00	$0	$0	$3,824	$12,530	$16,354
5.3 Compactor Attachment	4	day				$280.00	$0	$0	$0	$1,120	$1,120
5.4 Pavement Saw, 18 hp	3	day				$66.00	$0	$0	$0	$198	$198
5.5 Sheetpile	1,080	sf	$44.00				$47,520	$0	$0	$0	$47,520
5.6 Sheetpile Equipment (mob/demob)	2	ea	$25,000.00				$50,000	$0	$0	$0	$50,000
5.7 Dewatering Pump & Filter	7	day				$151.50	$0	$0	$0	$1,061	$1,061
5.8 Site Labor, (3 laborers)	75	day			$280.80		$0	$0	$21,060	$0	$21,060
5.9 Confirmation Sampling, lead	4	ea	$50.00	$30.00	$50.00	$30.00	$200	$120	$200	$120	$640
5.10 Confirmation Sampling, dioxin/furan	5	ea	$1,200.00	$30.00	$50.00	$30.00	$6,000	$150	$250	$150	$6,550
5.11 Confirmation Sampling, PCBs	5	ea	$160.00	$30.00	$50.00	$30.00	$800	$150	$250	$150	$1,350
5.12 T & D of Excavated Soil, hazardous	25	ton	$245.00				$6,125	$0	$0	$0	$6,125
5.13 T & D of Excavated Soil, non-hazardous	250	ton	$85.00				$21,250	$0	$0	$0	$21,250
5.14 T & D of Demo Materials	20	ton	$55.00				$1,100	$0	$0	$0	$1,100
5.15 Waste Disposal Characterization / Analytical	2	ea	$850.00	$30.00	$50.00	$30.00	$1,700	$60	$100	$60	$1,920
5.16 Backfill, common fill	186	cy		$18.33			$0	$3,409	$0	$0	$3,409
5.17 Geotextile Fabric	285	sy		$1.14			$0	$325	$0	$0	$325
5.18 Waste Water Line Removal, Bypass, Replacement	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
5.19 Storm Sewer Line Removal, Bypass, Replacement	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
5.20 Heat Cool Line Removal, Bypass, Replacement	1	ls	$12,500.00				$12,500	$0	$0	$0	$12,500
5.21 Pavement Repair (6" base, 2" binder, 1" top)	2,500	sf	$2.46				$6,150	$0	$0	$0	$6,150
6 POST CONSTRUCTION COST											
6.1 Contractor Completion Report	150	hr			$39.00		$0	$0	$5,850	$0	$5,850
6.2 Remedial Action Closeout Report	150	hr			$39.00		$0	$0	$5,850	$0	$5,850
Subtotal							$199,915	$19,292	$82,743	$24,865	$326,815

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @ 30%									$24,823		$24,823
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$19,992	$1,929	$8,274	$2,486	$32,681
Tax on Materials and Equipment Cost @ 6%								$1,158		$1,492	$2,649
Total Direct Cost							$219,907	$22,379	$115,840	$28,843	$386,969
Indirects on Total Direct Cost @ 30%		(excluding transportation and disposal cost)									$107,250
Profit on Total Direct Cost @ 10%											$38,697
Subtotal											$532,915
Health & Safety Monitoring @ 2%											$10,658
Total Field Cost											$543,573
Contingency on Total Field Costs @ 20%											$108,715
Engineering on Total Field Cost @ 20%											$108,715
TOTAL CAPITAL COST											**$761,003**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 3 - Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shoreline Controls
Shoreline Maintenance Years 15 and 30

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 MOBILIZATION AND DEMOBILIZATION											
1.2 Equipment Mobilization/Demobilization	3	ea			$188.00	$566.00	$0	$0	$564	$1,698	$2,262
2 FIELD SUPPORT AND SITE ACCESS											
2.1 Storage Trailer	1	mo				$94.00	$0	$0	$0	$94	$94
2.2 Survey Support	1	day	$1,150.00				$1,150	$0	$0	$0	$1,150
2.3 Site Superintendent	5	day		$153.00	$420.00		$0	$765	$2,100	$0	$2,865
3 SHORELINE MAINTENANCE											
3.1 Backfill, gravel	82	cy		$41.00			$0	$3,362	$0	$0	$3,362
3.2 Riprap	14	cy		$31.50			$0	$441	$0	$0	$441
3.3 Excavator, 2.5 cy long reach	5	day			$382.40	$2,312.80	$0	$0	$1,912	$11,564	$13,476
3.4 Front End Loader, 185 hp	5	day			$382.40	$611.00	$0	$0	$1,912	$3,055	$4,967
3.5 Site Labor, (3 laborers)	15	day			$280.80		$0	$0	$4,212	$0	$4,212
4 POST CONSTRUCTION COST											
4.1 Contractor Completion Report	80	hr			$39.00		$0	$0	$3,120	$0	$3,120
Subtotal							$1,150	$4,568	$39,560	$16,411	$61,689
Overhead on Labor Cost @ 30%									$11,868		$11,868
G & A on Labor, Material, Equipment, & Subs Cost @ 10%							$115	$457	$3,956	$1,641	$6,169
Tax on Materials and Equipment Cost @ 6%								$274		$985	$1,259
Total Direct Cost							$1,265	$5,299	$55,384	$19,037	$80,985
Indirects on Total Direct Cost @ 20%											$16,197
Profit on Total Direct Cost @ 10%											$8,098
Subtotal											$105,280
Health & Safety Monitoring @ 0%											$0
Total Field Cost											$105,280
Contingency on Total Field Costs @ 20%											$21,056
Engineering on Total Field Cost @ 15%											$15,792
TOTAL CAPITAL COST											**$142,128**

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 3 - Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shoreline Controls
Annual Cost

Item	Item Cost years 1 - 30	Item Cost every 5 years	Notes
Annual Site Inspection & Report	$2,950		Labor and supplies once a year to inspect Land Use Controls with Report.
Five Year Site Review		$23,000	Labor and supplies to evaluate site every five years for 5-year review
SUBTOTAL	$2,950	$23,000	
Contingency @ 10%	$295	$2,300	
TOTAL	**$3,245**	**$25,300**	

PORTSMOUTH NAVAL SHIPYARD
Kittery, Maine
OU7 FS
Alternative 3 - Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shoreline Controls
Present Worth Analysis

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Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate 2.0%	Present Worth
0	$761,003		$761,003	1.000	$761,003
1		$3,245	$3,245	0.980	$3,181
2		$3,245	$3,245	0.961	$3,119
3		$3,245	$3,245	0.942	$3,058
4		$3,245	$3,245	0.924	$2,998
5		$28,545	$28,545	0.906	$25,854
6		$3,245	$3,245	0.888	$2,881
7		$3,245	$3,245	0.871	$2,825
8		$3,245	$3,245	0.853	$2,770
9		$3,245	$3,245	0.837	$2,715
10		$28,545	$28,545	0.820	$23,417
11		$3,245	$3,245	0.804	$2,610
12		$3,245	$3,245	0.788	$2,559
13		$3,245	$3,245	0.773	$2,508
14		$3,245	$3,245	0.758	$2,459
15	$142,128	$28,545	$170,673	0.743	$126,813
16		$3,245	$3,245	0.728	$2,364
17		$3,245	$3,245	0.714	$2,317
18		$3,245	$3,245	0.700	$2,272
19		$3,245	$3,245	0.686	$2,227
20		$28,545	$28,545	0.673	$19,210
21		$3,245	$3,245	0.660	$2,141
22		$3,245	$3,245	0.647	$2,099
23		$3,245	$3,245	0.634	$2,058
24		$3,245	$3,245	0.622	$2,017
25		$28,545	$28,545	0.610	$17,399
26		$3,245	$3,245	0.598	$1,939
27		$3,245	$3,245	0.586	$1,901
28		$3,245	$3,245	0.574	$1,864
29		$3,245	$3,245	0.563	$1,827
30	$142,128	$28,545	$170,673	0.552	$94,224

TOTAL PRESENT WORTH **$1,126,630**

APPENDIX D

AREA AND QUANTITY CALCULATIONS

CLIENT: PORTSMOUTH NAVAL SHIPYARD		JOB NUMBER: 112G02100 - FS.DR.DF
SUBJECT: OU7 FS - QUANTITY CALCULATIONS		
BASED ON:		DRAWING NUMBER:
BY: LW Date: 10/06/2011	CHECKED BY AMC Date: 05/17/2012	APPROVED BY: MDK DATE: 01/02/2013

PURPOSE:

The purpose of this calculation is to determine the volumes, areas, and quantities of materials associated with the remedial action alternatives presented in the OU7 FS. These material and volume quantities are presented within the FS text and are used to support the cost estimates provided in Appendix C.

DISCUSSION:

The volume, area, and quantity calculations presented below are based on the descriptions of the alternatives presented in Section 4.0 of the text and FS Figures 4-1 and 4-2.

CALCULATIONS:

Alternative 2 - Land Use Controls and Long-term Management of Shoreline Controls

Alternative 2 includes the implementation of land use controls and long term management of the shorline controls identified in Figure 4-1.

Land use control area

Area of the LUC limits on Fig. 4-1 = 839,080 sf

Five year reviews are also required under this alternative.

Alternative 3 - Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shorline Controls

Alternative 3 includes excavation of PCB, lead, and dioxin/furan contaminated soil in the former timber basin, LUCs, and long term management. All excavated soil will be characterized and disposed off-site. The excavation areas will be backfilled to existing grade and surface conditions will be returned. The following presents the volumes quantities of materials involved in the excavation and cover construction process.

Excavation Areas

Area 1
Assume a 10ft x 10ft areal extent at TP-SB27 with Lead (Surface) and Dioxins/Furans (Subsurface) Contamination

Area = 100 sf
Depth = 5 ft
(Assume no shoring is required)

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BY: LW Date: 10/06/2011	CHECKED BY AMC Date: 05/17/2012	APPROVED BY: MDK	DATE: 01/02/2013

Volume =	500	cf
=	19	cy

Area 2

Assume a 10ft x 50ft areal extent at TP-SB112 (PCBs Contamination at 5-8ft bgs) and TP-SB108/14 (PCBs Contamination at 3-9ft bgs)

Area =	500	sf
Depth =	9	ft
(Assume shoring is required)		
Volume =	4500	cf
=	167	cy

Total Volume of Material Excavated and Disposed Off-site = 185 cy

Confirmation samples will be collected from the floor and sidewalls of each excavation area.

Number of Confirmation Samples = 14 samples

Characterization sampling for off-site disposal will be collected at a rate of 1 sample for every 500 cy of material going off-site for disposal or at least 1 sample from each excavation area

Number of Characterization Samples = 2 samples

Assume the excavated material from the hot spots will be disposed as hazardous waste.

Following excavation and off-site disposal, excavated areas will need to be backfilled and restored to site condition. The following calculations present the volume of material needed to backfill the excavation areas and the volume of material needed to construct the asphalt cover.

Volume of Backfill Material for Area 1 =	19	cy
Area of pavement (from excavation only)=	100	sf
Assume the area of pavement needs replacement =	200	sf
(to account for damage by excavation equipment)		
Top 9-inches asphalt pavement =	6	cy
Volume of Backfill Soil for Area 1 =	16	cy
Volume of Backfill Material for Area 2 =	167	cy
Area of pavement (from excavation only)=	500	sf
Assume the area of pavement needs replacement =	700	sf
(to account for damage by excavation equipment)		

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SUBJECT: OU7 FS - QUANTITY CALCULATIONS			
BASED ON:		DRAWING NUMBER:	
BY: LW Date: 10/06/2011	CHECKED BY AMC Date: 05/17/2012	APPROVED BY: MDK	DATE: 01/02/2013

Top 9-inches asphalt pavement =	19	cy
Volume of Backfill Soil for Area 2 =	153	cy
Total Volume of Backfill Soil =	169	cy
Total Area of Pavement to restore for Excavation Areas =	900	sf (9-inch thick section)

LUCs

Alternative 3 also includes the implementation of LUCs.

Area of the LUC limits on Fig. 4-2 = 839,080 sf

Five Year Reviews

Five year reviews are also required under this alternative.

APPENDIX E

ENVIRONMENTAL FOOTPRINT EVALUTION

APPENDIX E.1

ENVIRONMENTAL FOOTPRINT REPORT

APPENDIX E

Environmental Footprint Evaluation
Feasibility Study
Operable Unit 7
Portsmouth Naval Shipyard
Kittery, Maine
January 2013

Objective

This Environmental Footprint Evaluation of remedial alternatives is provided as an appendix to the Feasibility Study (FS) for Operable Unit 7 (OU7) located at Portsmouth Naval Shipyard (PNS), in Kittery, Maine. The purpose of the footprint evaluation is to assess the environmental impacts of remedial alternatives using the metrics of greenhouse gas (GHG) and criteria pollutant emissions, energy use, water consumption, and worker safety. The results of this footprint evaluation are intended to provide additional information for consideration during remedy selection, design, and enhance the understanding of the environmental impacts throughout the remedy life-cycle for each of the proposed alternatives.

Policy Background

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout (NAVFAC, 2010a).

In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009, DOD issued a policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the Department of the Navy (DON) issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (NAVFAC, 2010a), which includes environmental footprint evaluations as part of the traditional DON optimization review process for remedy selection, design, and remedial action operation. In August 2010, the Naval Facilities Engineering Command (NAVFAC) issued a policy requiring use of the SiteWise™ tool to perform environmental impact reviews as part of all Feasibility Studies. As such, this environmental footprint evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of reducing the environmental impact of remedial actions at PNS OU7.

Applying the DON optimization concepts with an environmental footprint evaluation during the remedy selection and design phases allows for the following benefits:

- Determining factors in each remedial alternative with the greatest environmental impacts and gathering insight into how to reduce these impacts;
- Evaluating remedial alternatives with optimized or reduced environmental footprints in conjunction with other selection criteria;
- Designing and implementing a more robust remedy while balancing the impact to the environment; and
- Ensuring efficient, cost-effective and sustainable site closeout.

Evaluation Tools

This evaluation was performed using a hybrid model of the Navy's SiteWise™ tool supplemented with a Tetra Tech developed model as appropriate for some site-specific items.

SiteWise™ is a life-cycle footprint assessment tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle. SiteWise™ assesses the environmental footprint of a remedial alternative/technology using a consistent set of metrics. The assessment is conducted using a building block approach, where every remedial alternative is first broken down into modules that mimic the remedial phases in most remedial actions, including remedial investigation (RI), remedial action construction (RAC), remedial action operation (RA-O), and long-term monitoring (LTM). Once broken down by remedial phase, the footprint of each phase is calculated. The phase-specific footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the footprint assessment and facilitates the identification of specific impact drivers that contribute to the environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

GSRx (Green Sustainable Remediation Tool) builds off of SiteWise™ and allows for a flexible, detailed analysis, particularly for materials and equipment use. GSRx was used to account for materials and activities not readily input into SiteWise™ and where equipment usage assumptions built into SiteWise™ were not consistent with site-specific requirements.

Environmental Footprint Evaluation Framework and Limitations

The environmental footprint evaluation performed for the PNS OU7 FS considered life-cycle quantitative metrics for global warming potential (through greenhouse gas emissions), criteria air pollutant emissions, energy consumption, water usage, and worker safety.

Life cycle impacts were calculated for energy consumption, emissions of GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) and criteria pollutants (nitrogen oxides [NO_x], sulfur oxides [SO_x] and particulate matter [PM_{10}]), water usage, and energy consumption, and worker safety.

Life cycle inventory inputs in SiteWise™ were divided into four categories – 1) materials production; 2) transportation of personnel, materials and equipment; 3) equipment use and miscellaneous; and 4) residual handling. Cost estimates from the FS and design calculations were used as a basis for inventory quantities and related assumptions. Emission factors, energy consumption, and water usage data were correlated to material quantities, equipment, transportation distances, and installation time frames in order to calculate life-cycle emissions, energy consumption, water usage, and worker safety. Default SiteWise™ emission, energy usage, water consumption, and worker fatality and accident risk factors were utilized.

Although GSRx was used to minimize limitations resulting within SiteWise™, elimination of all limitations was not possible while using a hybrid model of SiteWise™ and GSRx. For example, several materials and construction equipment inventoried were input into GSRx and these impacts were incorporated into SiteWise™ within the "Equipment Use and Miscellaneous" sector. This sector in SiteWise™ does not differentiate into the specific equipment usage or material consumption items that are input in GSRx, but rather are considered miscellaneous items. However, impact drivers for items input in GSRx can be identified and evaluated directly within the respective GSRx evaluation and output summary sheets. In addition, worker safety results in general do not include worker safety related to equipment usage that was input within GSRx because GSRx was not developed to evaluate worker safety.

Evaluation Results

The following are the alternatives that were analyzed with SiteWise™ and GSRx for the OU7 FS:

- Alternative 2: Land Use Controls (LUCs) and Long-Term Management (LTMgt) of Shoreline Controls
- Alternative 3: Limited Excavation in Former Timber Basin Area, Residential LUCs, and Long-term Management of Shoreline Controls

The following sections summarize the relative environmental impacts and primary impact drivers for the two alternatives and respective metrics. In addition, the attachment includes the inventory and output sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the footprint evaluation attachments (Appendix E-2 and E-3), provides detailed information on the contribution to each metric from each phase of the remedial process (RI, RAC, RAO, and LTM) and for each respective input category (materials production, transportation, equipment usage, etc). Further inspection of related inventory sheets provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously. The environmental impacts of the two alternatives analyzed are summarized quantitatively in Table E1.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure E1 shows a comparison of the overall GHG emissions of each of the alternatives analyzed; the x-axis represents the two alternatives evaluated and the y-axis represents the GHG emissions in metric tons of CO_2e. The estimated GHG emissions for Alternative 3 are a total of 51.18 metric tons of CO_2e. The GHG emissions for Alternative 2 are 15.64 metric tons of CO_2e.

For Alternative 2, the highest activity contributing to GHG emissions is in the use of the excavator, which contributes 40 percent to the total emissions (6.20 metric tons of CO_2e). The second highest contributor to the GHG emissions is the production of gravel, where the total emissions from this activity are 3.87 metric tons of CO_2e (corresponding to 25 percent of the total emissions). The use of the front loader contributes 2.07 metric tons of CO_2e corresponding to approximately 13 percent of the total GHG emissions.

For Alternative 3, the highest contributor for GHG emissions is the use of the excavator, contributing 24 percent to the total GHG emissions (12.41 metric tons of CO_2e). The second highest contributor to GHG emissions is the production of HDPE, where 6.23 metric tons of CO_2e are released, approximately 12 percent of the total GHG emissions. The production of borrow soil is the third highest contributor to GHG emissions with 5.82 metric tons of CO_2e, approximately 11 percent of the total of GHG emissions.

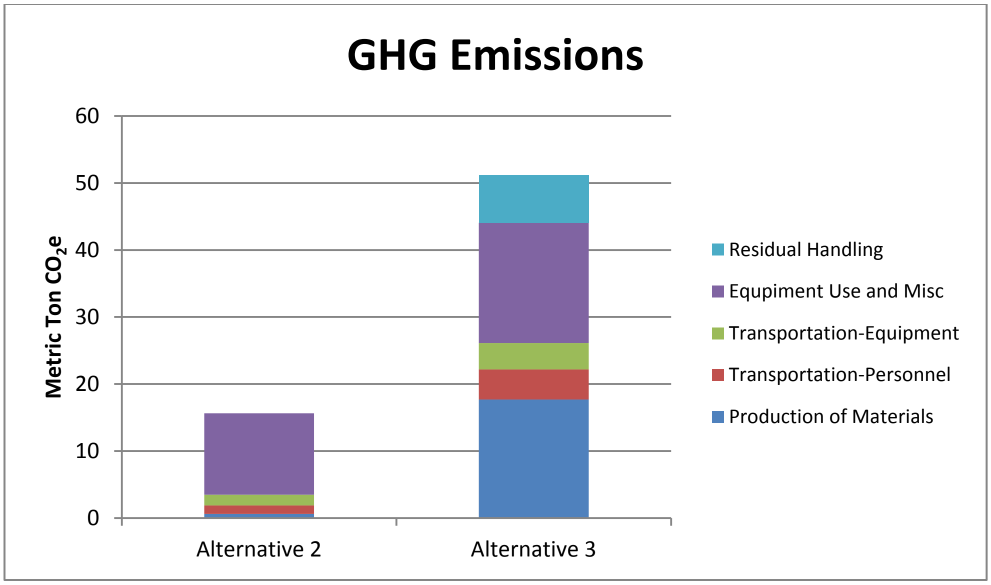

Figure E1: GHG Emissions for Proposed Alternatives at PNS OU7

Criteria Pollutant Emissions

NO_X

Figure E2 shoes the breakdown of the NO_X emissions for the two alternatives evaluated. The x–axis of this figure represents Alternative 2 and Alternative 3, the y-axis represents the NO_X emissions in metric tons.

Alternative 2 contributes a total of $5.9x10^{-2}$ metric tons of NO_X emissions. The use of the excavator during the maintenance and inspection of the shoreline contributes 66 percent to the total NO_X emissions ($3.9x10^{-2}$ metric tons of NO_X). The second highest contributor to NO_X emissions is the use of the front loader, which emits $1.89x10^{-2}$ metric tons of NO_X (32 percent of the total NO_X emissions). Transportation of personnel contributes with less than one percent to the total emissions ($4.65x10^{-4}$ metric tons of NO_X).

The total amount of NO_X emissions for Alternative 3 is $1.4x10^{-1}$ metric tons. The highest contributor to these emissions is the use of the excavator, where $7.08x10^{-2}$ metric tons of NO_X are released to the atmosphere, corresponding to 56 percent of the total emissions. The activity with the second highest contribution to NO_X emissions is the use of the loader, where $1.89x10^{-2}$ metric tons of NO_X are emitted, corresponding to approximately 14 percent of the total NO_X emissions released. The third highest contributor to NO_X emissions is the transportation and disposal of non-hazardous materials where $1.79x10^{-2}$ metric tons of NO_X, are released corresponding to approximately 13 percent of the total NO_X emissions.

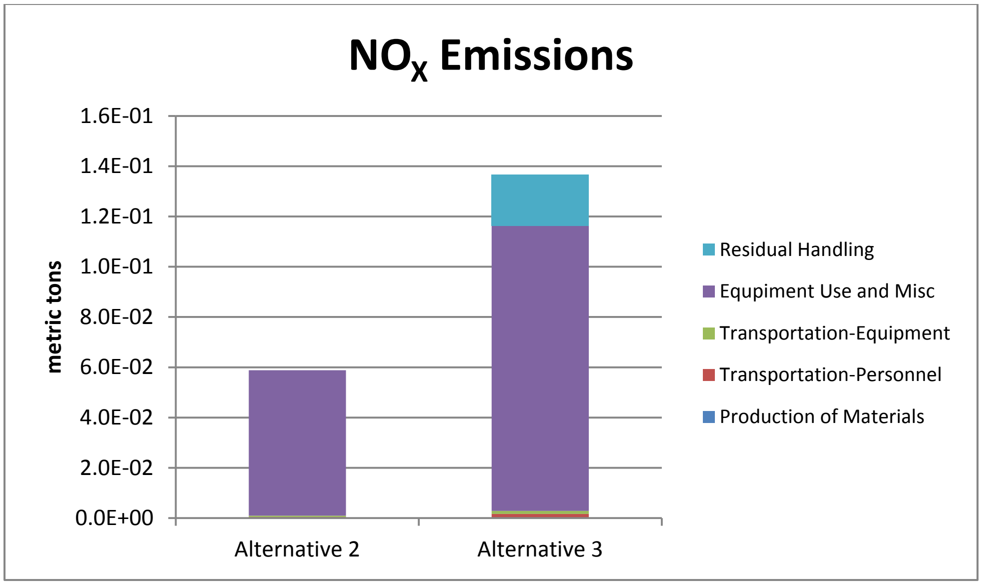

Figure E2 NO_X Emissions for Proposed Alternatives at PNS OU7

SO_X

Figure E3 contains the distribution of the SO_X emissions resulting from the activities related to Alternatives 2 and 3. The x-axis of this graph represents the alternatives evaluated; the y-axis represents the SO_X emissions in metric tons.

The SO_X emissions resulting from Alternative 2 are estimated to be $1.5x10^{-2}$ metric tons. The highest contributor to these emissions is the use of the excavator, where $1.15x10^{-2}$ metric tons of SO_X are emitted, corresponding to 74 percent of the total SO_X emissions. The activity with the second highest contribution to these emissions is the use of the front loader, where $3.92x10^{-3}$ metric tons of SO_X are emitted, corresponding to 25 percent of the total SO_X emissions. The activity with the third highest contribution to SO_X emissions is the transportation of personnel, where $1.64x10^{-5}$ metric tons of SO_X are released to the atmosphere, corresponding to less than one percent of the total SO_X emissions for Alternative 2.

A total emission of $5.6x10^{-2}$ metric tons of SO_X is estimated for Alternative 3. SO_X emissions are largely influenced by the equipment use and miscellaneous sector, where the highest contributor is the use of the excavator emitting $2.30x10^{-2}$ metric tons of SO_X, corresponding to 41 percent of the total emissions. The second highest contributor to SO_X emissions is the production of HDPE, with an estimated emission of $1.39x10^{-2}$ metric tons of SO_X, corresponding to approximately 25 percent of the total SO_X emissions. The transportation and disposal of non-hazardous materials corresponds to the third highest contributor to

SO_X emissions, emitting 9.20x10^{-3} metric tons of SO_X, approximately 16 percent of the total SO_X emissions.

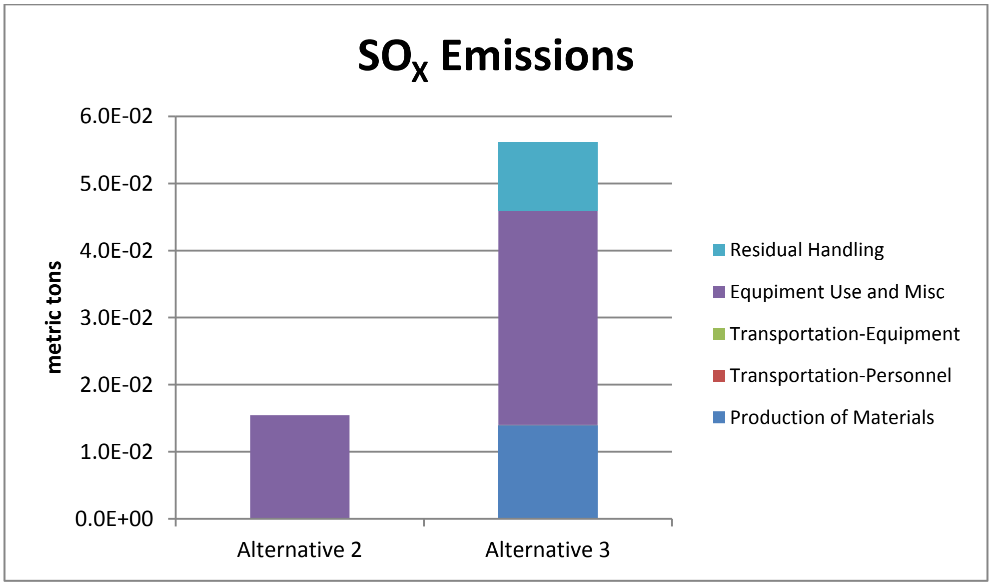

Figure E3: SO_X Emissions for Proposed Alternatives at PNS OU7

PM_{10}

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in Alternatives 2 and 3 are shown in Figure E4. The x-axis of this figure represents the two alternatives evaluated, while the y-axis represents the PM_{10} emissions in metric tons.

Alternative 2 contributes a total of 6.1x10^{-3} metric tons of PM_{10} emissions. The activity with the highest contribution to PM_{10} emissions is the use of the excavator where 3.7x10^{-3} metric tons of PM_{10} are released, corresponding to 61 percent of the total PM_{10} emissions. The activity with the second highest contribution to PM_{10} emissions is the use of the front loader, where 2.3x10^{-3} metric tons of PM_{10} corresponding to approximately 37 percent of the total emissions. The activity with the third highest contribution is the transportation of personnel, where 9.4x10^{-5} metric tons of PM_{10} which corresponds to approximately 1.5 percent of the total PM_{10} emissions.

The total emission of PM_{10} resulting from Alternative 3 is estimated to be 2.8x10^{-1} metric tons. The highest contributor to these emissions is the production of asphalt contributing 2.11x10^{-1} metric tons of PM_{10} corresponding to approximately 75 percent of the total PM_{10} emissions. Residual handling operations is the activity with the second highest contribution to PM_{10} emissions, where 4.91x10^{-2} metric tons of PM_{10} are released, corresponding to approximately 17 percent of the total PM_{10} emissions released during the lifetime of this Alternative. The third highest contributor to these emissions is the use of the excavator, contributing 7.42×10^{-3} metric tons of PM_{10} that is approximately three percent of the total PM_{10} emissions.

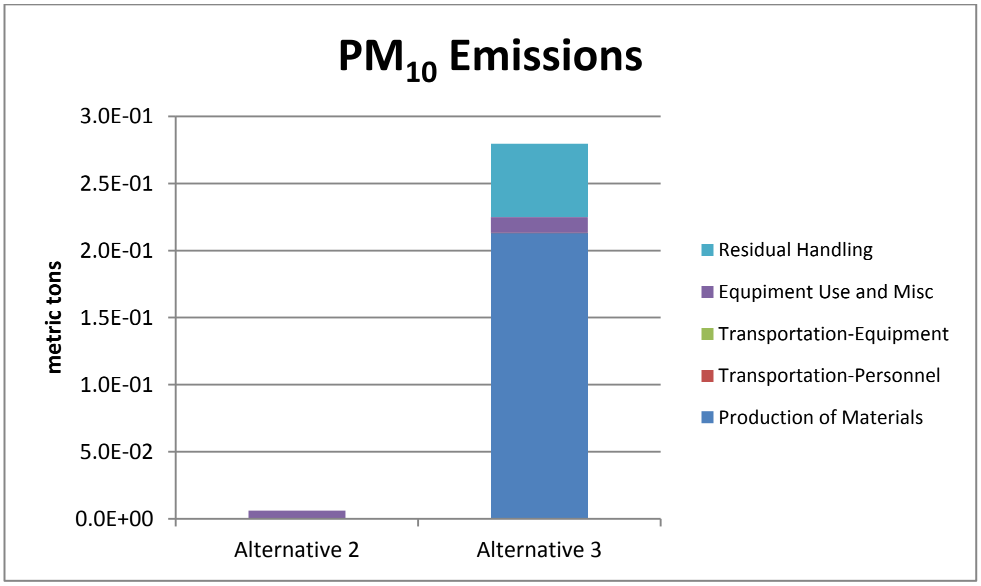

Figure E4: PM_{10} Emissions for Proposed Alternatives at PNS OU7

Energy Consumption

The energy consumption of the alternatives evaluated is shown in Figure E5. The x-axis shows the two alternatives evaluated, and the y-axis shows the amount of energy consumed in units of million Brittish Thermal Units (MMBTU).

Alternative 2 consumes 526 MMBTU. The activity with the highest consumption of energy is the production of gravel for the backfill of the shoreline, where 315 MMBTU are consumed corresponding to approximately 60 percent of the total energy for this Alternative. The use of the excavator consumes 96 MMBTU, corresponding to 18 percent of the total energy consumed. The production of rip rap has an energy use of 52 MMBTU, which corresponds to 10 percent of the total energy consumption.

The energy consumption from Alternative 3 is 1,541 MMBTU. The activity with the highest consumption of energy is the production of materials (1089 MMBTU, 71 percent of the total energy consumed). Production of, borrow soil for backfilling consumes 524.8 MMBTU, which is the most energy intense component of Alternative 3, corresponding to 34 percent of the total energy used through this alternative. The activity with the second highest energy consumption is the productions of gravel, where 426.4 MMBTU are consumed, corresponding to approximately 28 percent of the total energy consumption. The secondary component of energy consumption is the equipment use and miscellaneous sector where 267.25 MMBTU are used, corresponding to 17 percent of the total energy. Within the equipment use and miscellaneous, the use of the excavator has an energy consumption of 192.15 MMBTU corresponding to 12 percent of the total energy consumption of this Alternative. Residual handling operations consume 55 MMBTU corresponding to approximately four percent of the total amount of energy utilized during Alternative 3.

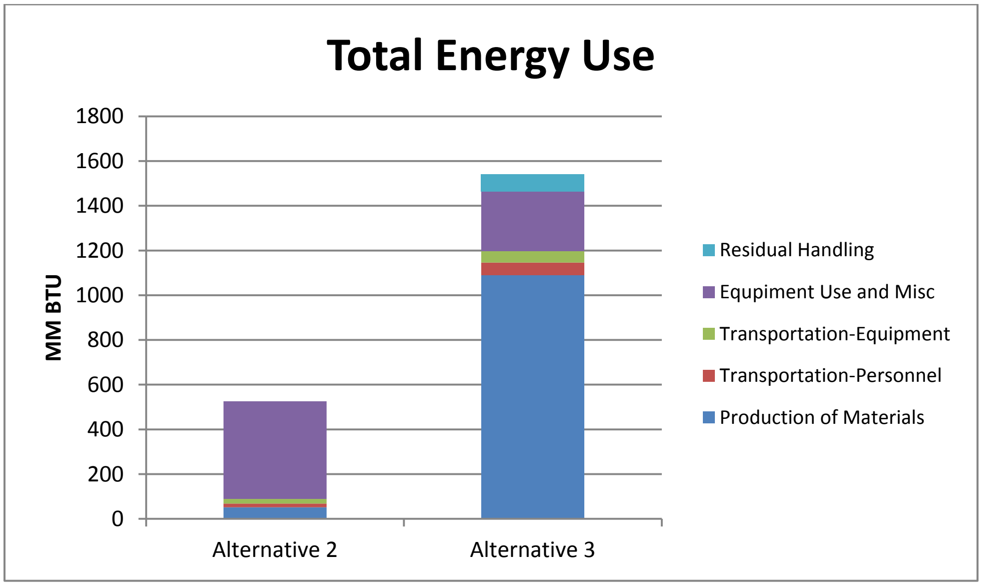

Figure E5: Energy Consumption for Proposed Alternatives at PNS OU7

Water Usage

The water consumption of the two alternatives is shown in Figure E6. The x-axis shows the two evaluated alternatives, and the y-axis show the amount of water consumed in gallons.

There is no direct water consumption assumed for Alternative 2.

Alternative 3 consumes a total of 2,092 gallons of water. The decontamination water utilizes 1000 gallons of water, which corresponds to 48 percent of the total water consumption; the production of HDPE that is used for the geotextiles consumes a thousand gallons of water, corresponding to 48 percent of the total water consumption. The generation of electricity for the pumps consumes 86 gallons of water, corresponding to approximately four percent of the total water consumption.

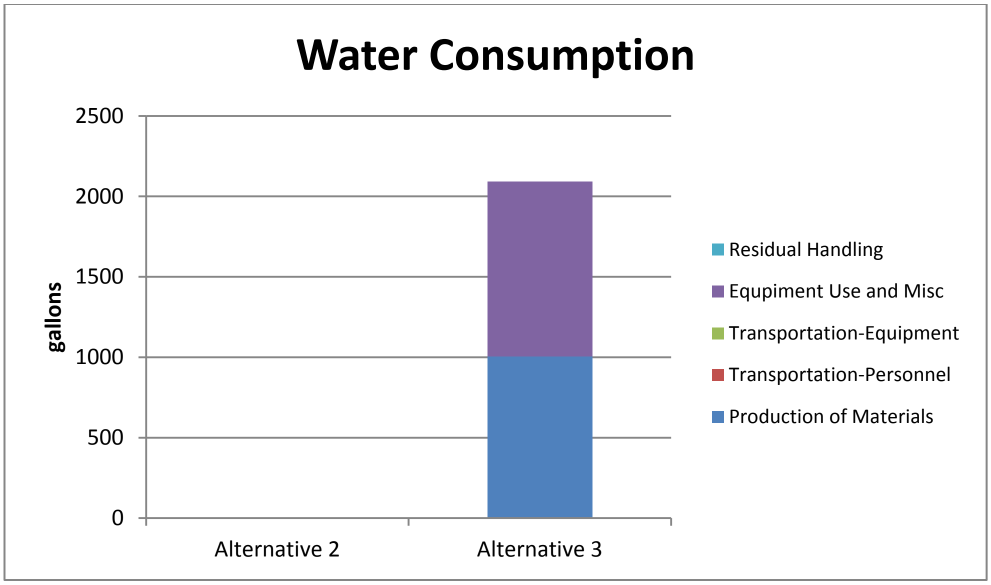

Figure E6: Water Consumption for Proposed Alternatives at PNS OU7

Accident Risk

Accident Risk Fatality

Figure E7 shows the risk of fatality between the two alternatives. The x-axis represents the two alternatives evaluated, and the y-axis represents the risk of fatality.

For Alternative 2, the activity with the highest risk of fatality is the transportation of personnel. Equipment use is the activity with the second highest risk for fatality, followed by the transportation of equipment and materials.

For Alternative 3, the activity with the highest risk of fatality is the transportation of personnel, followed by equipment use and miscellaneous.

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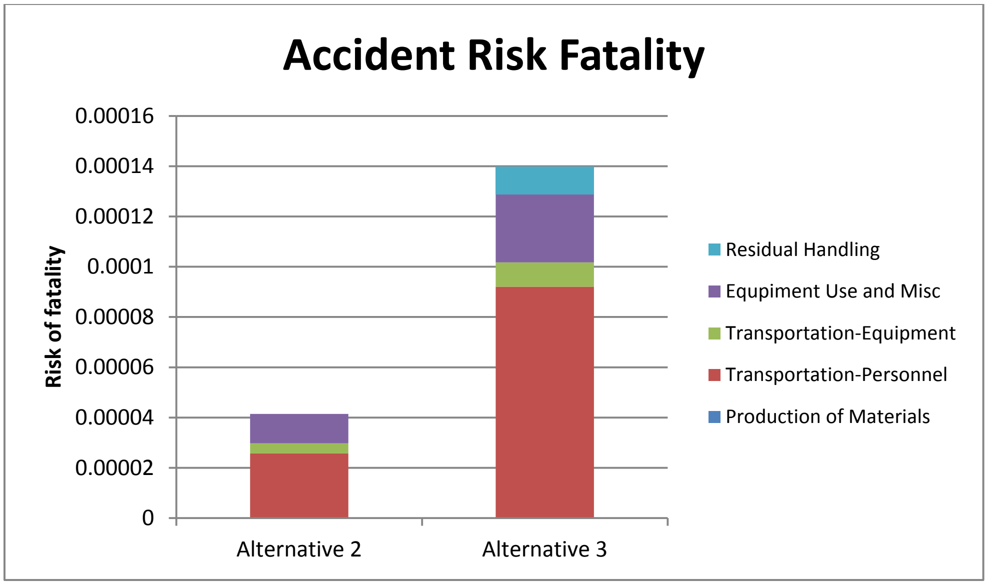


Figure E7 Risk of Fatality for Proposed Alternatives at PNS OU7

Accident Risk Injury

Figure E8 shows the risk of injury between the two alternatives. The x-axis represents the two alternatives evaluated, and the y-axis represents the risk of injury.

For Alternatives 2 and 3, the activity with the highest risk of injury is the equipment use and miscellaneous, followed by transportation of personnel.

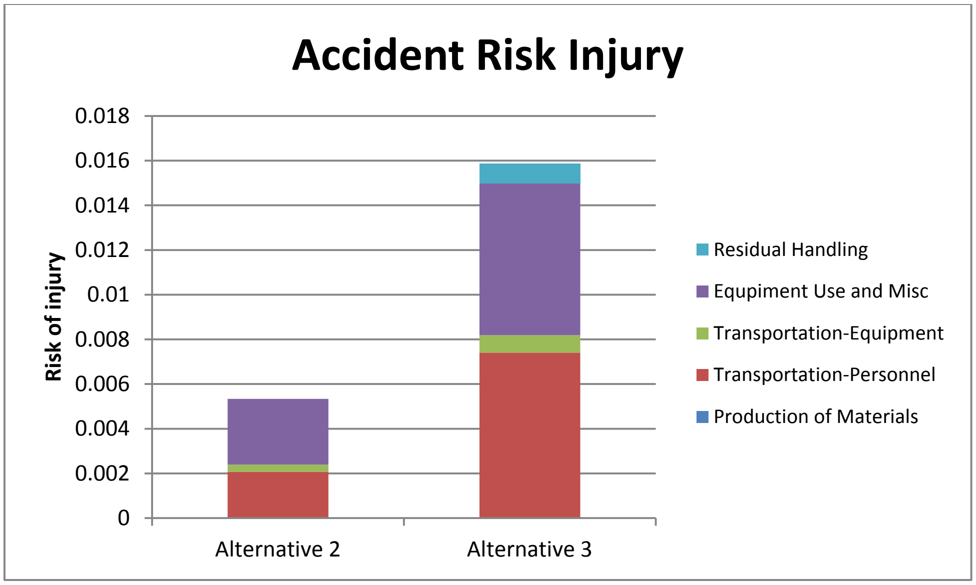


Figure E8 Risk of Injury for Proposed Alternatives at PNS OU7

<u>Conclusions and recommendations</u>

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table E2 for details).

Some activities from Alternative 3 were not incorporated into this analysis due to the lack of information. The items that were not considered were the waste water, storm sewer line, and heat/cool line removal, bypass and replacement. These items are thought to be energy intensive due to the nature of the construction activities embedded in them. The description of these items is not defined to where inventory and evaluation of these components could be completed. It is expected that most (if not all) of the impact categories would be higher once these activities are incorporated into the analysis.

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- Alternative 3: The amount of soil needed for backfilling has a high impact on the amount of energy consumed; consider revisions and optimization of this amount to lower the need of clean borrow soil.

- Alternative 3: Consider the option of obtaining clean fill from on-site sources, or from the closest source available, to reduce material transportation emissions.
- Alternatives 2 and 3: Consider ways to reduce vehicle mileage to reduce worker risk as well as energy use and emissions. Encourage site workers to carpool daily to the site to reduce total vehicle mileage.
- Alternatives 2 and 3: Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.
- Alternative 3: Consider optimization of the use of equipment, and even the type of equipment used during operations could make a difference in the environmental impacts.
- Alternative 3: Additional testing and characterization of excavated soils during the remedial investigation may reduce the amount of hazardous waste soils requiring transport to a hazardous waste facility.
- Alternative 3: if warranted by the amount of soils and transportation distance, consider transporting hazardous waste via in order to reduce emissions and energy consumption.

REFERENCES

(a) NAVFAC 20120a, DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010

(b) NAVFAC 2010b, DON Policy on SiteWise™ Optimization/GSR Tool Usage, email received from Brian Harrison/NAVFAC HQ dated 10 AUG 2010

Table E1
Environmental Impact Results
OU7, Portsmouth Naval Shipyard
Kittery, Maine

Alternative	Activities	GHG Emissions metric ton	Total Energy Used MMBTU	Water Impacts gallons	NOx Emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Alternative 2	Materials Production	0.64	52.12	0.000	0.0E+00	0.0E+00	0.0E+00	NA	NA
	Transportation-Personnel	1.26	15.82	NA	4.7E-04	1.6E-05	9.4E-05	2.6E-05	9.2E-05
	Transportation-Equipment	1.60	21.45	NA	5.1E-04	1.6E-05	4.3E-05	4.0E-06	9.7E-06
	Equipment Use and Misc	12.14	436.50	0.000	5.8E-02	1.5E-02	6.0E-03	1.2E-05	2.7E-05
	Residual Handling	0.00	0.00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-05
	Total	15.64	525.88	0.000	5.9E-02	1.5E-02	6.1E-03	4.1E-05	1.4E-04
Alternative 3	Materials Production	17.69	1089.16	1006.3	0.0E+00	1.4E-02	2.1E-01	NA	NA
	Transportation-Personnel	4.50	56.56	NA	1.7E-03	5.9E-05	3.4E-04	2.1E-03	7.4E-03
	Transportation-Equipment	3.93	51.25	NA	1.2E-03	2.2E-05	1.1E-04	3.2E-04	7.8E-04
	Equipment Use and Misc	17.97	267.25	1085.6	1.1E-01	3.2E-02	1.2E-02	2.9E-03	6.8E-03
	Residual Handling	7.11	77.16	NA	2.0E-02	1.0E-02	5.5E-02	0.0E+00	9.0E-04
	Total	51.18	1541.39	2091.8	1.4E-01	5.6E-02	2.8E-01	5.3E-03	1.6E-02

Table E2
Environmental Impact Drivers
OU7, Portsmouth Naval Shipyard
Kittery, Maine

Remedial Alternatives	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
Alternative 2	Low to moderate	Low to moderate	Low	Moderate	Low to moderate	Low	Low to moderate	Low to moderate
	Equipment use - Excavator	Production of materials - gravel	No water consumption	Equipment use: Excavato	Equipment use: Excavato	Equipment use: Excavato	Transportation of Personnel	Equipment Use
Alternative 3	High	High	High	High	High	High	High	High
	Equipment use - Excavator	Production of materials - production of borrow soil	Decontamination water (1000 gallons)	Equipment use - Excavator	Equipment use - Excavator	Production of materials - production of asphalt	Transportation of Personnel	Transportation of Personnel

APPENDIX E.2

INPUT INVENTORIES AND ASSUMPTIONS

Alternative 2: LUCs and Shoreline Maintenance/Inspection

LTM

Materials

Item	Quantity	Units	Comments
riprap	69,266.19	lb	13.5 CY of riprap, assume gravel, 1522 kg/m3, every 15 years, through year 30
Backfill gravel	418,162.58	lb	81.5 CY of gravel, assume gravel, 1522 kg/m3, every 15 years, through year 30

Transportation-Personnel

Item	Quantity	Units	Comments
Annual Site Inpsection	1500	miles	1 day per year, 2 trips/day, 25 miles/trip, 1 person, 30 years
5-year Site Review	300	miles	1 day per year, 2 trips/day, 25 miles/trip, 1 person, 6 years
Labor	1500	miles	5 days, 50 miels per trip, 3 people, every 15 years, through 30 years

Transportation-equipment

Item	Quantity	Units	Comments
Front End Loader, 4 CY (185 hp)	44.01	ton	1 loader, 44005 lb per unit, 100 miles round trip, every 15 years, through 30 years
Excavator, 2.5 CY	40.00	ton	1 excavator, 20 ton per excavator, 100 miles round trip

Transportation-materials

Item	Quantity	Units	Comments
riprap	34.63	ton	13.5 CY of riprap, assume gravel, 1522 kg/m3, every 15 years, through year 30
Backfill gravel	209.08	ton	81.5 CY of gravel, assume gravel, 1522 kg/m3, every 15 years, through year 30

Equipment Use

Item	Quantity	Units	Comments
Loader, 4 CY	192	hours	5 days, 8 hours per day, 80% utilization, every 5 years, through year 30
Excavator, 2.5 CY	192	hours	5 days, 8 hours per day, 80% utilization, every 5 years, through year 30

Residual Handling

Item	Quantity	Units	Comments

Transportation-residual handling

Item	Quantity	Units	Comments

Note: Quantities and items within this inventory do not reflect final design materials and quantities. Use of this inventory should not be used for costing or considered a final design.

Alternative 3: Limited Excavation in Former Timber Basin Area, Residential Land Use Controls, and Long-term Management of Shoreline Controls

RAC

Materials			
Item	Quantity	Units	Comments
Asphalt (crushed)	29050	lb	(2500 sf, 0 .083 ft thick, 140 lbs/ft3)
Sand (dry)	42500	lb	(2500 sf, 0 .17 ft thick, 100 lbs/ft3)
Concrete (gravel)	187500	lb	(2500 sf, 0 .5 ft thick, 150 lbs/ft3)
Temporary Equipment Decon Pad Liner	700.471211	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad Frame	514.683708	lb	Assume wood, 4x4 in, (30ftx40ft pad) 140 ft of timber, density for pine 530 kg/m3
Decon Water	1000	gal	1000 gal, 8.34 lb/gal, 2000 lb/ton
Backfill, common fill	558000	lb	186 cy, assume soil, 1.5 ton/cy; 50 miles in
Geotextile Fabric	2089.05	lb	Assume similar to US TM Track Mat (Extra Heavy),7.33 lbs/sy, given 285 sy, HDPE

Transportation-Personnel			
Item	Quantity	Units	Comments
Site Superintendent	1250	miles	25 days, 2 trips per day, 25 miles per trip, 1 person
Site health and safety and QAQC	2500	miles	25 days, 2 trips per day, 25 miles per trip, 2 people
Survey Support	300	miles	3 days, 2 trips per day, 25 miles per trip, 2 people
Site Labor, (3 laborers)	3750	miles	25 days, 2 trips per day, 25 miles per trip, 3 people

Transportation-equipment			
Item	Quantity	Units	Comments
Equipment Mobilization/ Demomobilization	30	ton	3 trailers, 10 tons per trailer, 100 miles roundtrip
Clean Water Storage Tank, 4,000 gallon	0.6	ton	4000 gallons capacity HPDE, 100 miles round trip, 150 lb per 500 gal capacity tank
Decon Water Storage Tank, 6,000 gallon	0.9	ton	6000 gallons capacity, HPDE, 100 miles round trip, 150 lb per 500 gal capacity tank
Fence, 6 ft high chain link	0.324	ton	108 lb per 50 ft long, galvanized steel
Excavator, 2.5 cy	20	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Pavement Saw, 18 hp	0.14	ton	280 lb per saw, 1 pavement saw, 100 miles round trip
Compactor Attachment	20	ton	1 compactor, 20 tons per compactor, assumed 120 hp, 100 miles roundtrip
Sheetpile	5.049	ton	1080 sf, assume 9.35 lb/sf, assume 100 miles round trip
Dewatering Pumps	0.025	hrs	1 pump, 50 lb prt pump, assume 5 hp
Asphalt paver	3.5	tons	PUCKETT MODEL 540, 7000 lbs, 100 miles roundtrip
Tandem Asphalt Pavement Roller	1	ton	BW 900-50 light tandem roller, 1 ton, 100 miles roundtrip

Transportation-materials			
Item	Quantity	Units	Comments
Asphalt (crushed)	15	ton	(2500 sf, 0 .083 ft thick, 140 lbs/ft3)
Sand (dry)	21	ton	(2500 sf, 0 .17 ft thick, 100 lbs/ft3)
Concrete (gravel)	94	ton	(2500 sf, 0 .5 ft thick, 150 lbs/ft3)
Temporary Equipment Decon Pad Liner	0.35023561	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad Frame	0.25734185	ton	Assume wood, 4x4 in, (30ftx40ft pad) 140 ft of timber, density for pine 530 kg/m3
Backfill, common fill	279	ton	186 cy, assume soil, 1.5 ton/cy; 50 miles in
Geotextile Fabric	1.044525	ton	Assume similar to US TM Track Mat (Extra Heavy),7.33 lbs/sy, given 285 sy, HDPE

Lab Services			
Item	Quantity	Units	Comments
Lab Services Analysis	3200	dollars	16 samples, $200 per sample.

Equipment Use			
Item	Quantity	Units	Comments
Compactor Attachment	25.6	hrs	assumed 120 hp, assumed 8 hr/day, 4 days, assume diesel, 80% utilization
Excavator, 2.5 cy	64	hrs	1 excavators, 10 days, assumed 8 hrs/day, 80% utilization
Pavement Saw, 18 hp	19.2	hrs	3 days, 8 hours per day, 80% utilization
Dewatering Pumps	44.8	hrs	7 days, 8 hours per day, 80% utilization
Asphalt paver	6.4	hrs	1 asphalt paver, 130 hp, 1 tandum roller, 10 tons, 1 day of equipment use, 80% utilization
Tandem Asphalt Pavement Roller	6.4	hrs	BW 900-50 light tandem roller, 1 ton, 1 day of use 80% utilizatio

Residual Handling			
Item	Quantity	Units	Comments
Disposal of Decon Waste (liquid & solid)	4.17	ton	1000 gal decon water, 8.34 lb/gal, 2000 lb/ton
T & D of Excavated Soil, hazardous	25	ton	25 ton
T & D of Demo Materials	20	ton	20 ton
T & D of Excavated Soil, non-hazardous	250	ton	250 ton

Transportation-residual handling			
Item	Quantity	Units	Comments
Disposal of Decon Waste (liquid & solid)	100	miles	(1000 gal decon water, 8.34 lb/gal, 2000 lb/ton)=4.17 tons, 100 miles out
T & D of Excavated Soil, hazardous	530	miles	278 tons, 100 miles out
T & D of Demo Materials	100	miles	20 tons, 100 miles out
T & D of Excavated Soil, non-hazardous	100	miles	20 tons, 100 miles out

RAO

Materials			
Item	Quantity	Units	Comments
Backfill Gravel	420,728.00	lb	82 CY, assume 1522 kg/cm3, year 15 and year 30
Rip Rap	71,831.61	lb	Assume gravel, 14 CY, 1522 kg/cm3, year 15 and year 30

Transportation-Personnel			
Item	Quantity	Units	Comments
Site Survey Support	200	miles	1 day, 25 miles per trip, 2 trips per day, 2 people, year 15 and year 30
Site Superintendent	500	miles	5 days, 25 miles per trip, 2 trips per day, 1 person, year 15 and year 30
Site Labor	1500	miles	5 days, 25 miles per trip, 2 trips per day, 3 people, year 15 and year 30

Transportation-equipment			
Item	Quantity	Units	Comments
Front End Loader, 4 CY (185 hp)	44.01	ton	1 loader, 44005 lb per unit, 100 miles round trip, year 15 and year 30
Excavator, 2.5 CY	40.00	ton	1 excavator, 20 ton per excavator, 100 miles round trip, year 15 and year 30

Transportation-materials			
Item	Quantity	Units	Comments
Backfill Gravel	210.36	ton	82 CY, assume 1522 kg/cm3, year 15 and year 30
Rip Rap	35.92	ton	Assume gravel, 14 CY, 1522 kg/cm3, year 15 and year 30

Equipment Use			
Item	Quantity	Units	Comments
Excavator, 2.3 CY	64	hours	5 days, 8 hours per day, 80% utlization, year 15 and year 30
Front End Loader, 185 hp	64	hours	5 days, 8 hours per day, 80% utlization, year 15 and year 30

Residual Handling			
Item	Quantity	Units	Comments

Transportation-residual handling			
Item	Quantity	Units	Comments

LTM

Materials			
Item	Quantity	Units	Comments

Transportation-Personnel			
Item	Quantity	Units	Comments
Annual Site Inpsection	1500	miles	1 day per year, 2 trips/day, 25 miles/trip, 1 person, 30 years
5-year Site Review	300	miles	1 day per year, 2 trips/day, 25 miles/trip, 1 person, 6 years

Transportation-equipment			
Item	Quantity	Units	Comments

Transportation-materials			
Item	Quantity	Units	Comments

Equipment Use			
Item	Quantity	Units	Comments

Note: Quantities and items within this inventory do not reflect final design materials and quantities. Use of this inventory should not be used for costing or considered a final design.

APPENDIX E.3

SITEWISE™ RESULTS

SiteWise Results Alternative 2
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

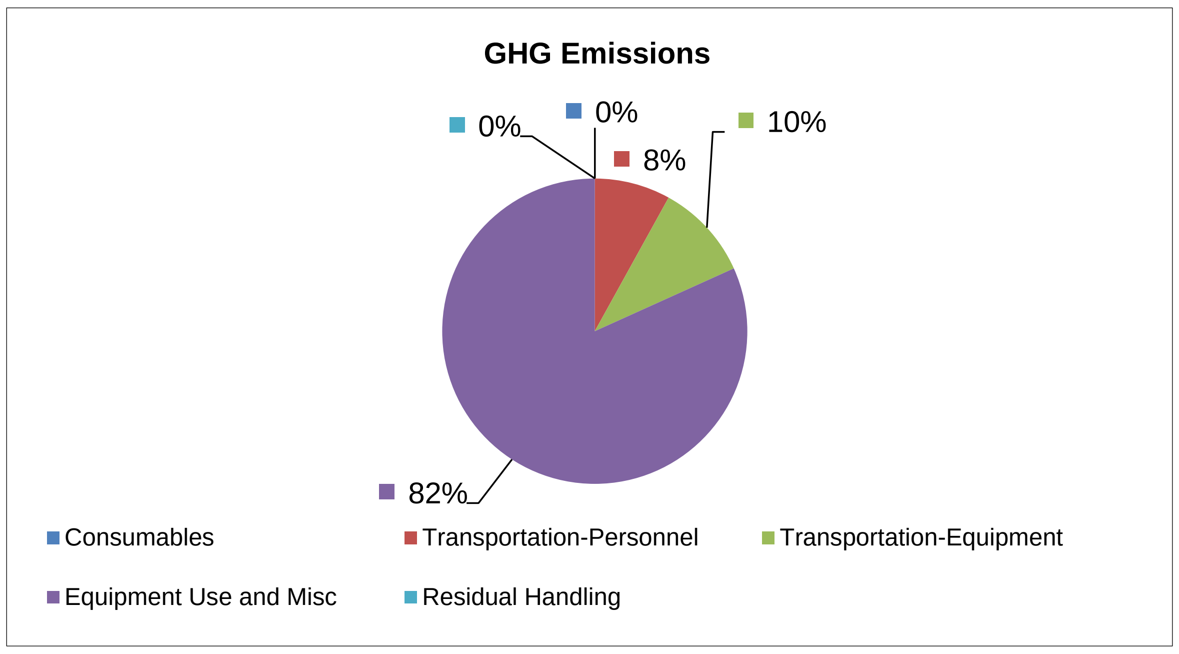
Sustainable Remediation - Environmental Footprint Summary
Alternative 2

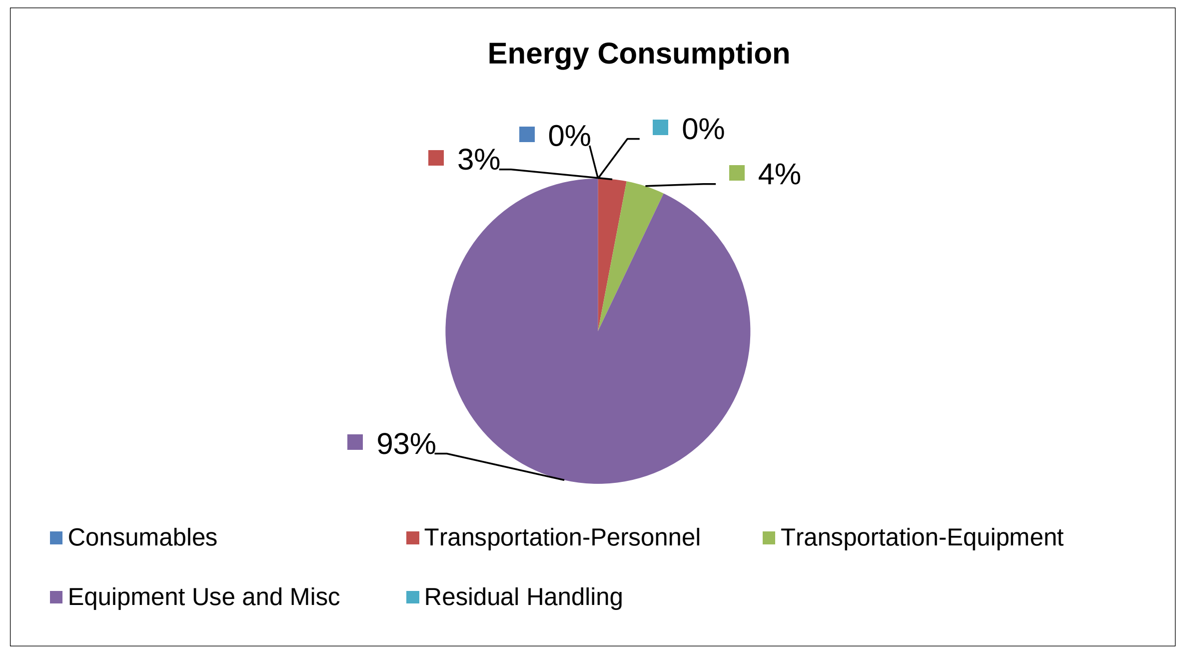
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	1.26	1.6E+01	NA	4.7E-04	1.6E-05	9.4E-05	2.6E-05	2.1E-03
	Transportation-Equipment	1.60	2.1E+01	NA	5.1E-04	1.6E-05	4.3E-05	4.0E-06	3.2E-04
	Equipment Use and Misc	12.78	4.9E+02	0.0E+00	5.8E-02	1.5E-02	6.0E-03	1.2E-05	2.9E-03
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	15.64	5.26E+02	0.00E+00	5.89E-02	1.55E-02	6.12E-03	4.15E-05	5.34E-03
Total		**1.6E+01**	**5.3E+02**	**0.0E+00**	**5.9E-02**	**1.5E-02**	**6.1E-03**	**4.1E-05**	**5.3E-03**

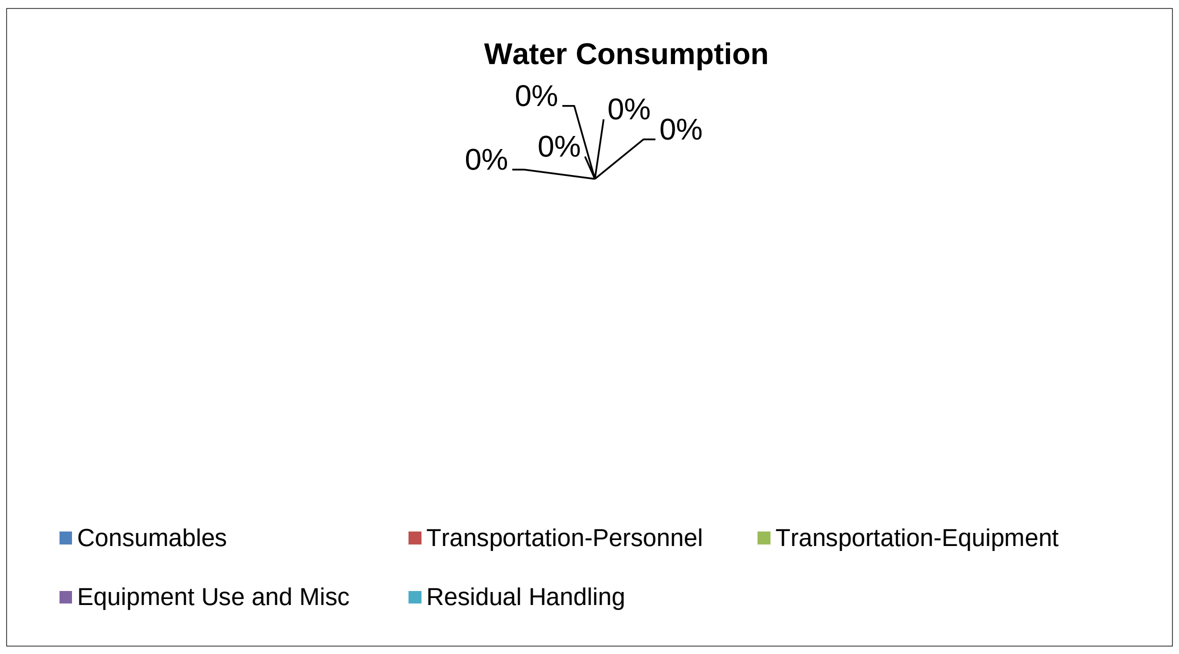
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space (tons)	Hazardous Waste Landfill Space (tons)	Topsoil Consumption (cubic yards)	Costing ($)	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	4.3E-02
Total	**0.0E+00**	**0.0E+00**	**0.0E+00**	**$0**	**4.3E-02**

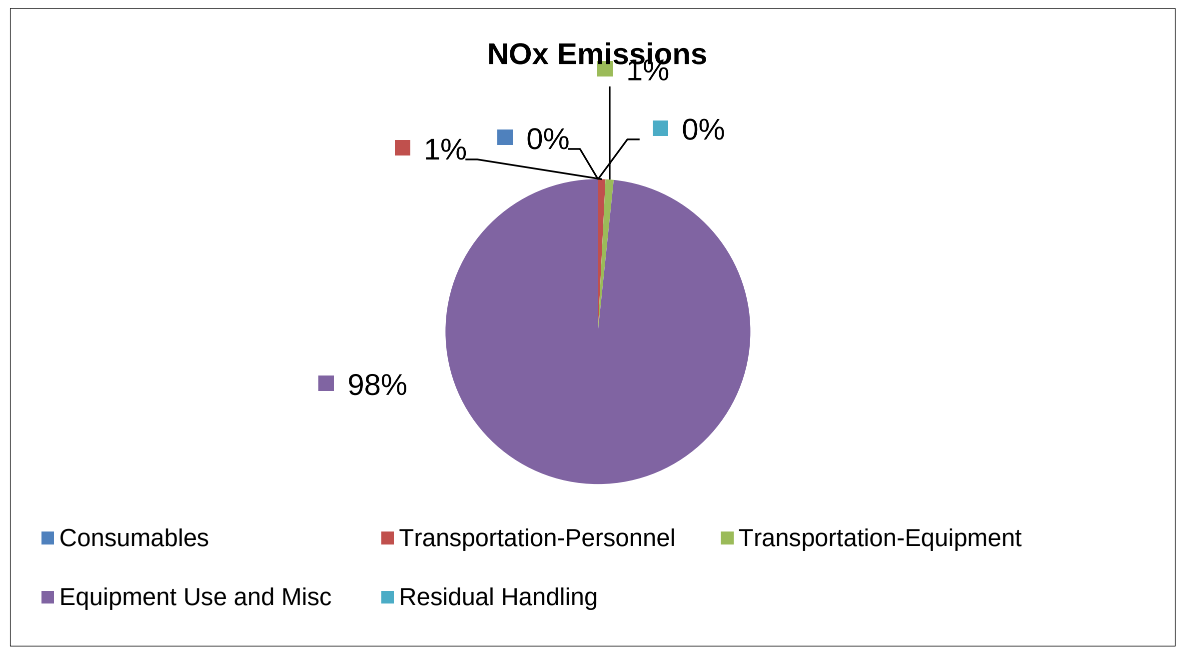
Total Cost with Footprint Reduction
$0

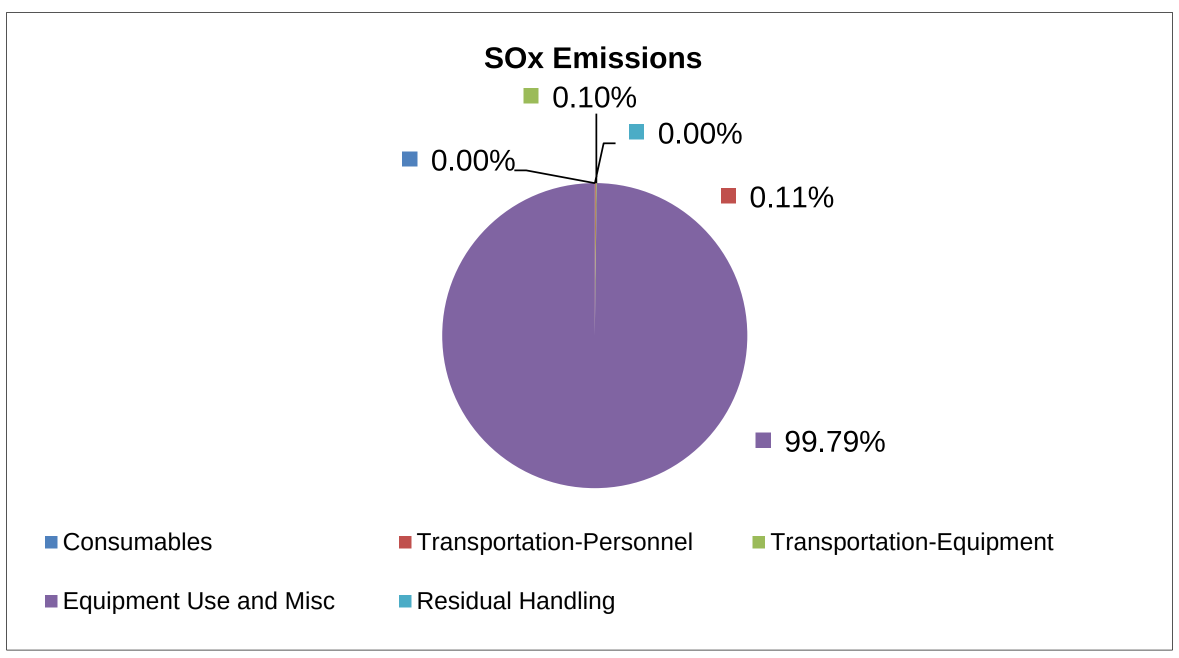
SiteWise Results Alternative 2
Long Term Management Stage
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

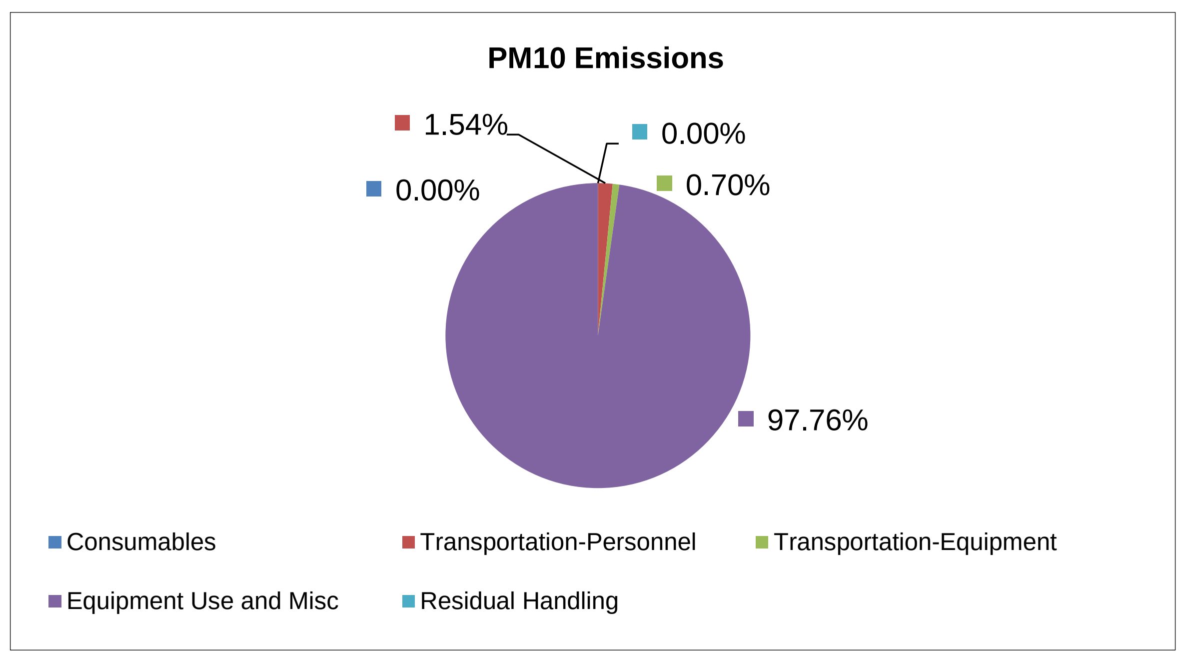


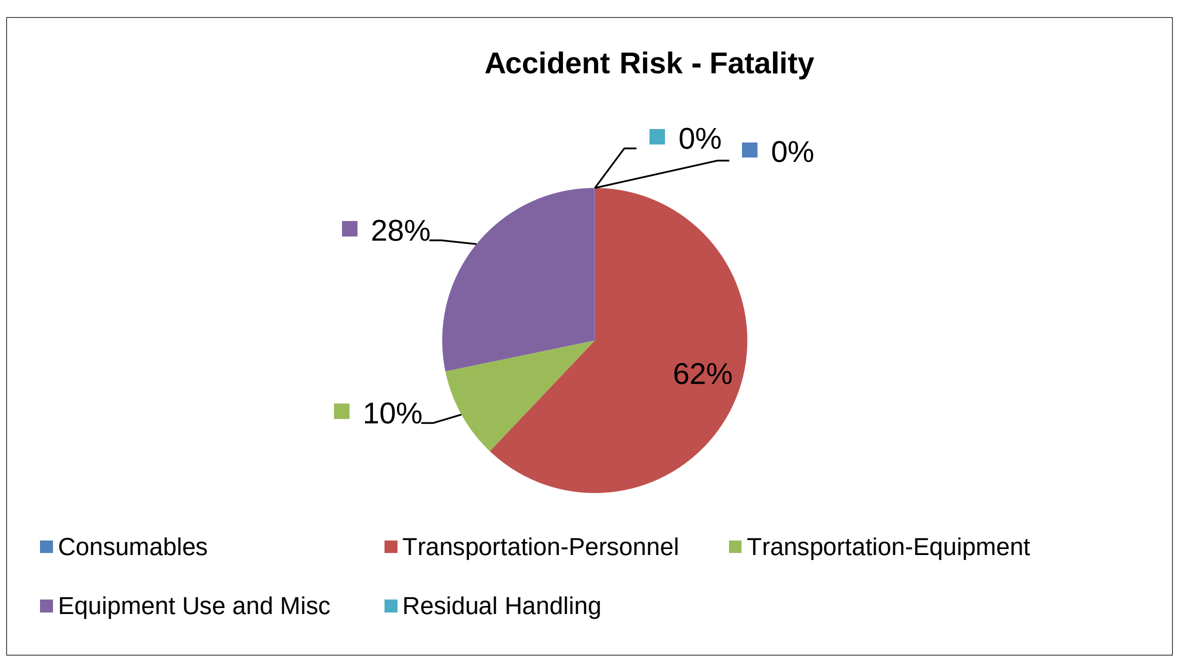


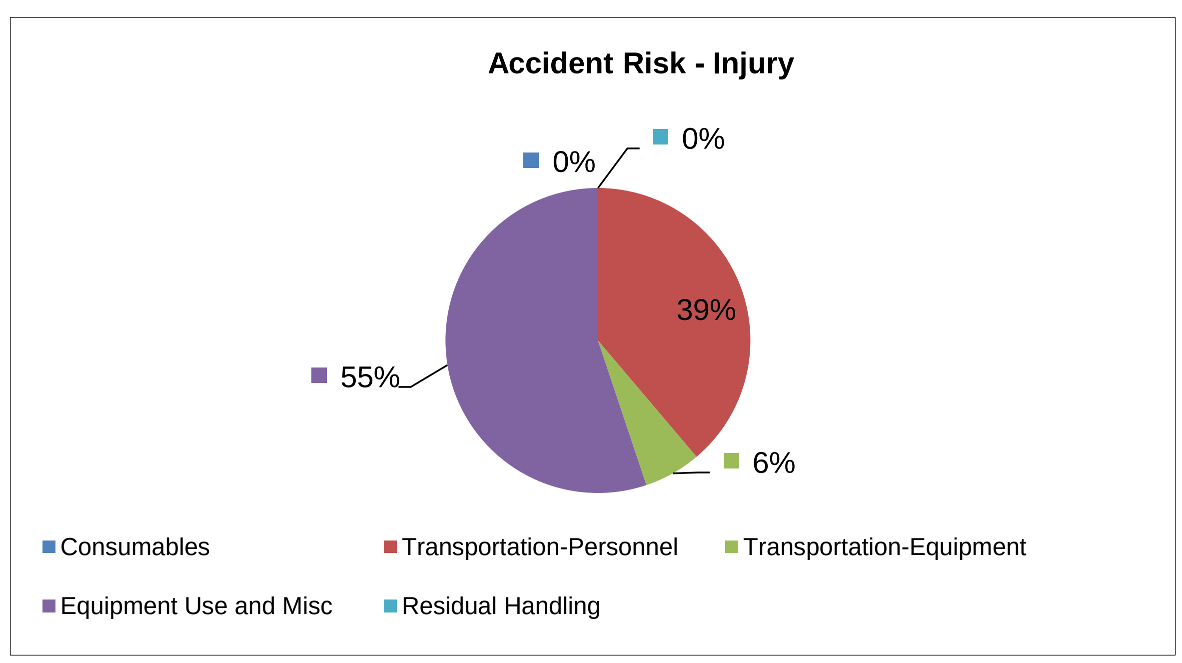




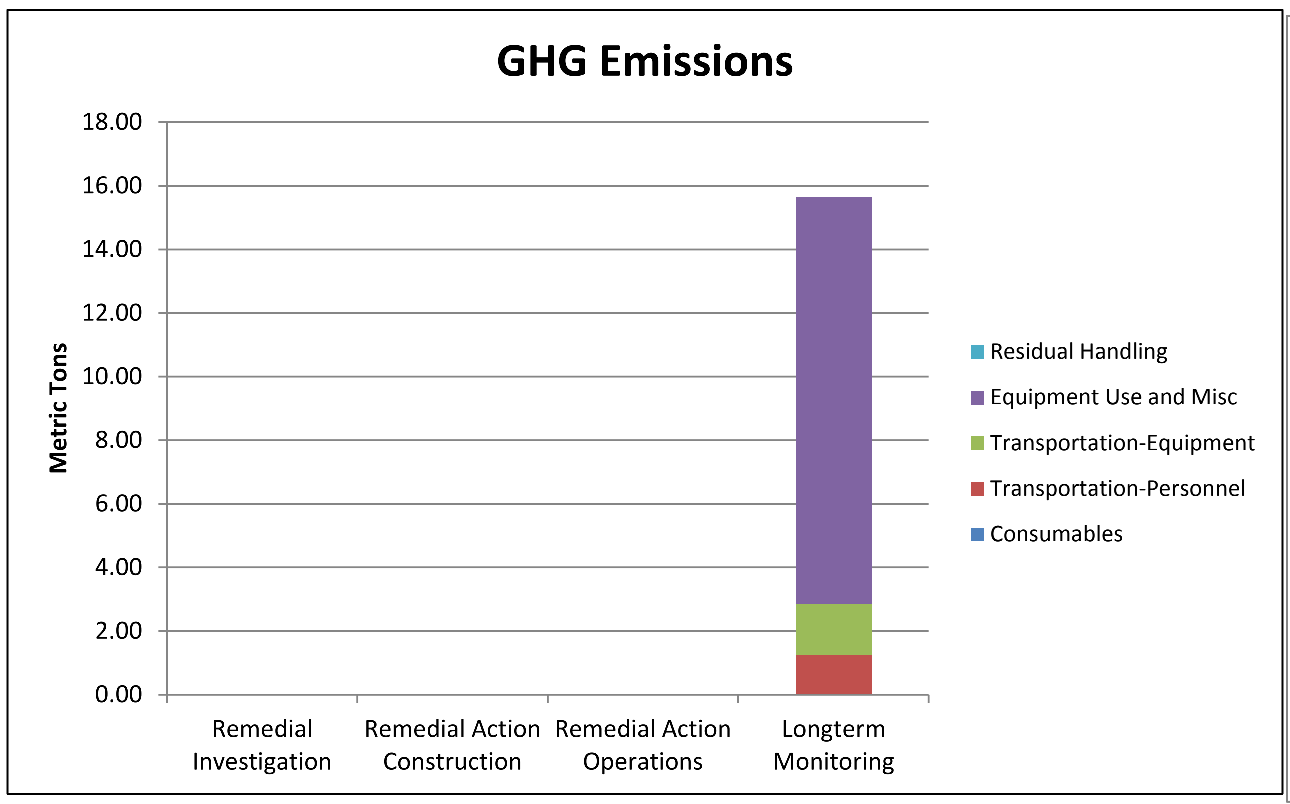


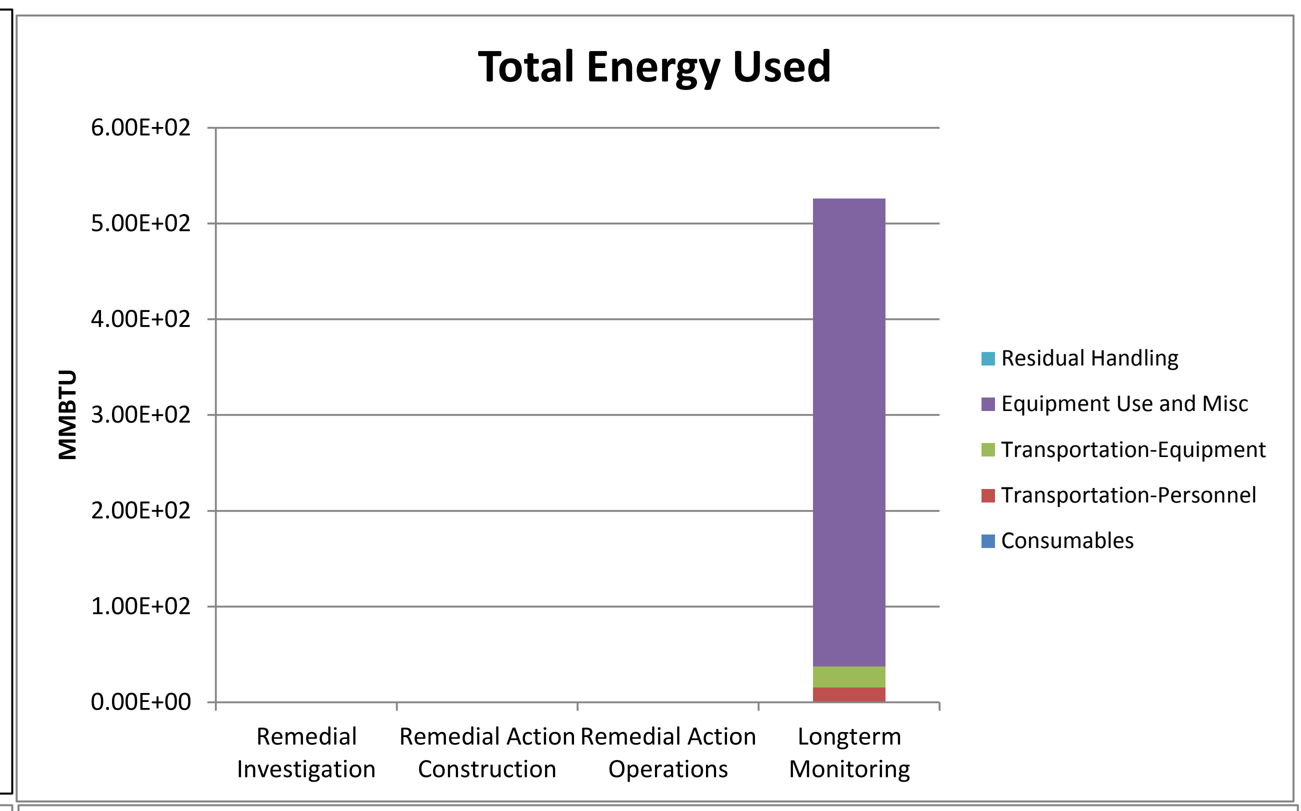


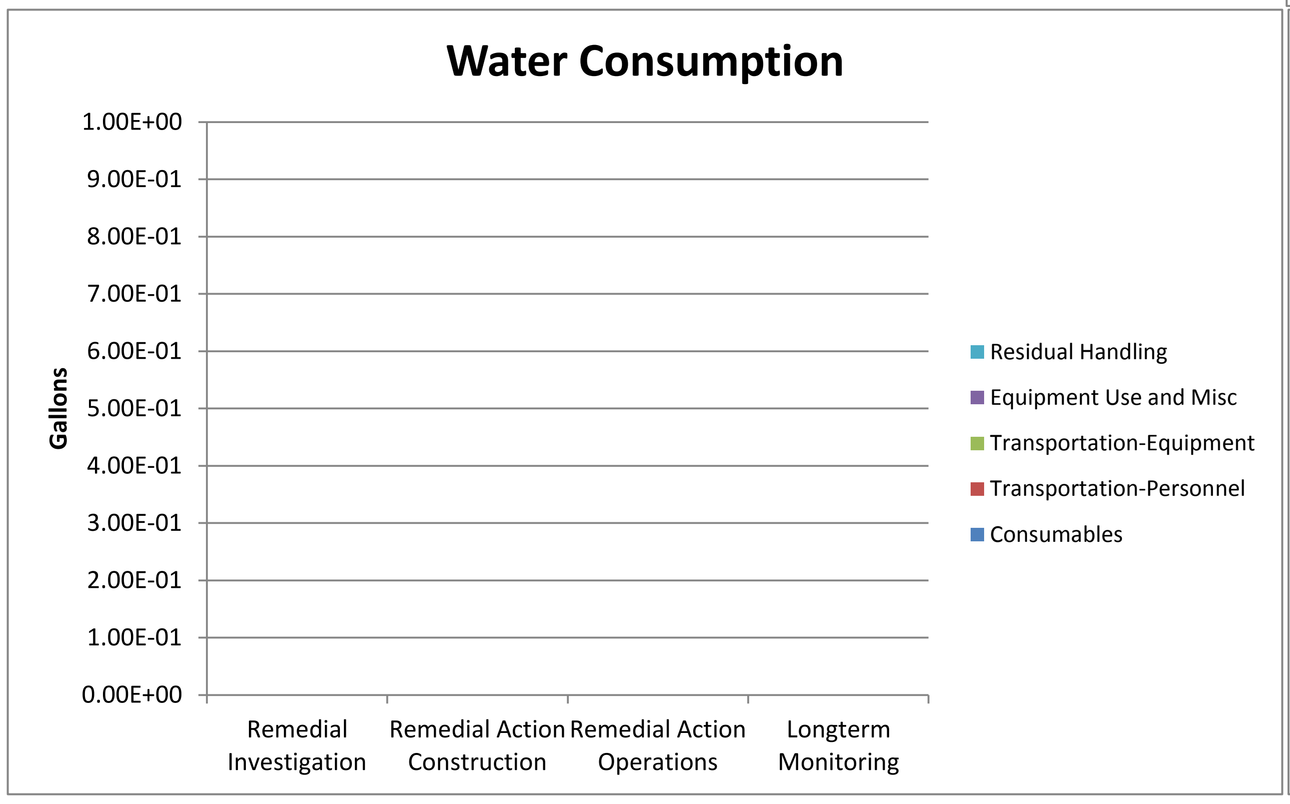


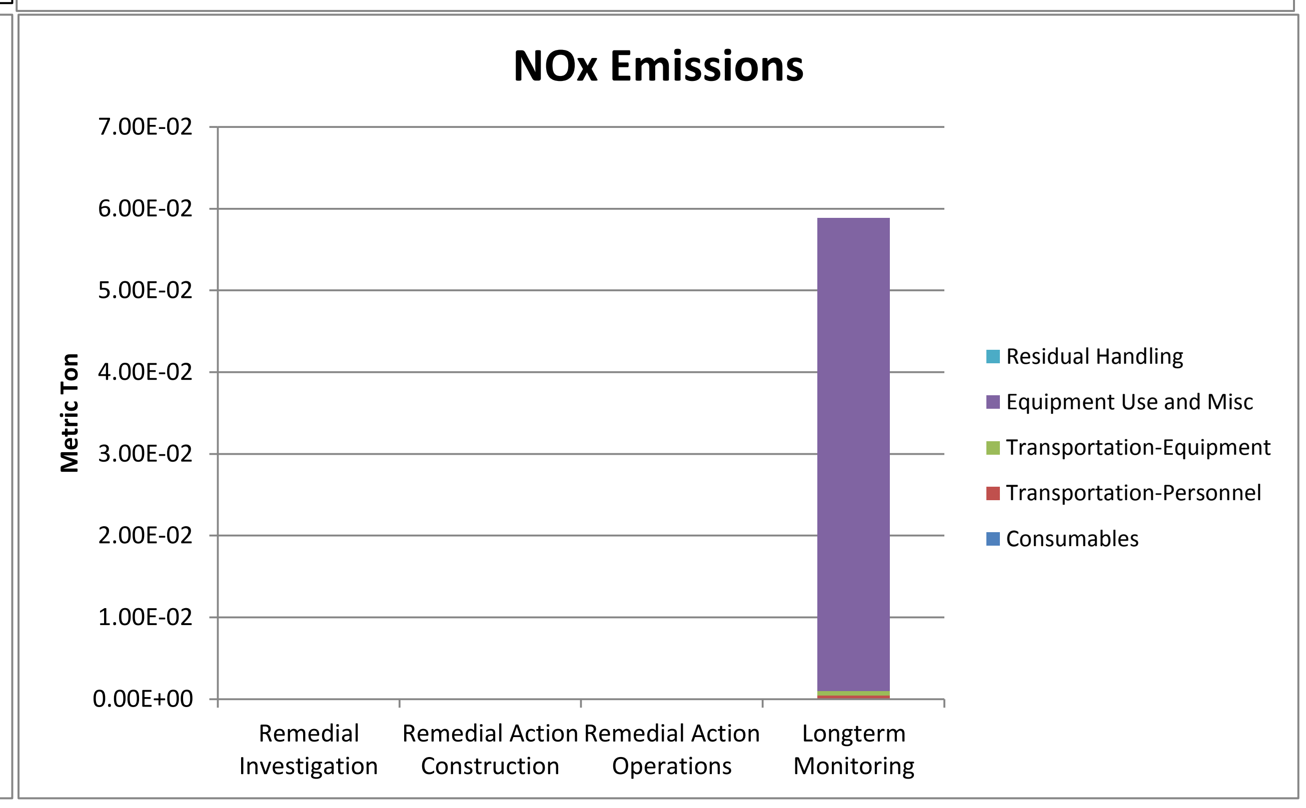


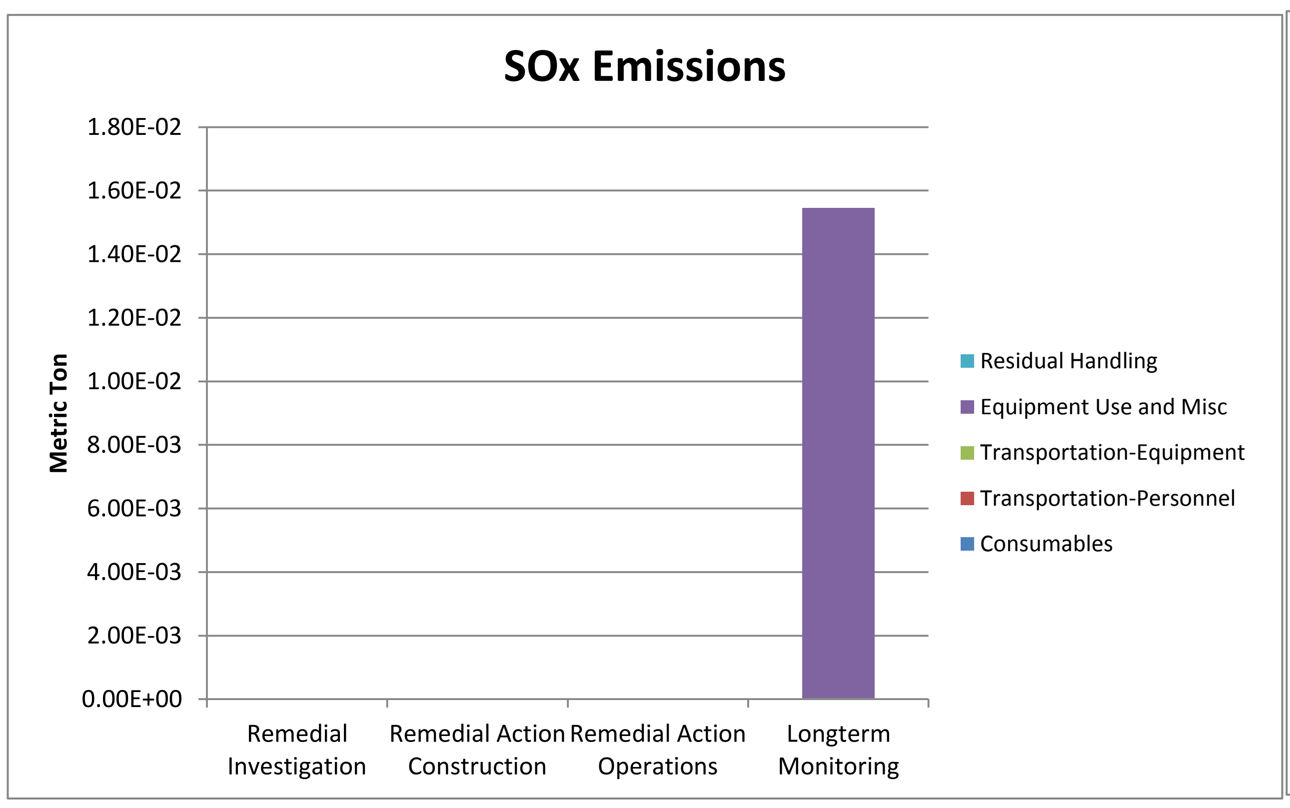
SiteWise Results Alternative 2
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

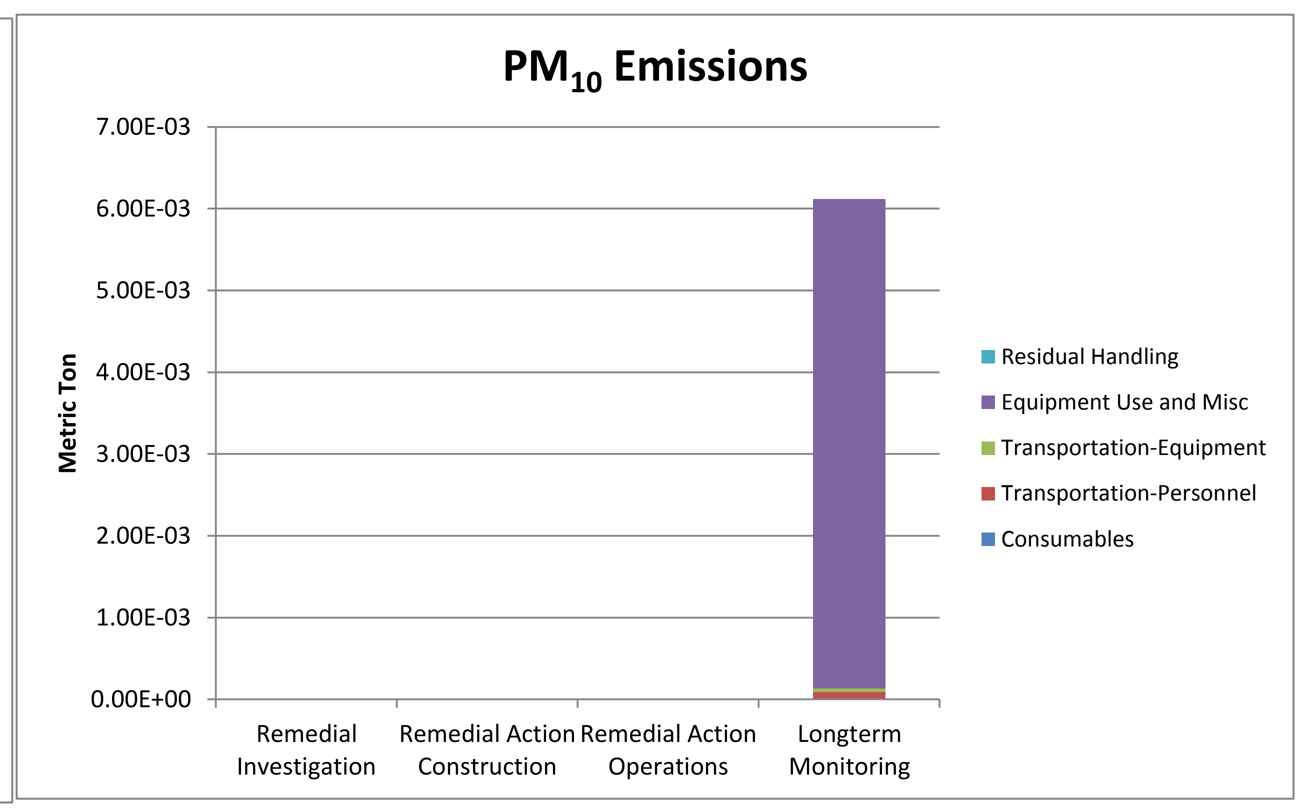


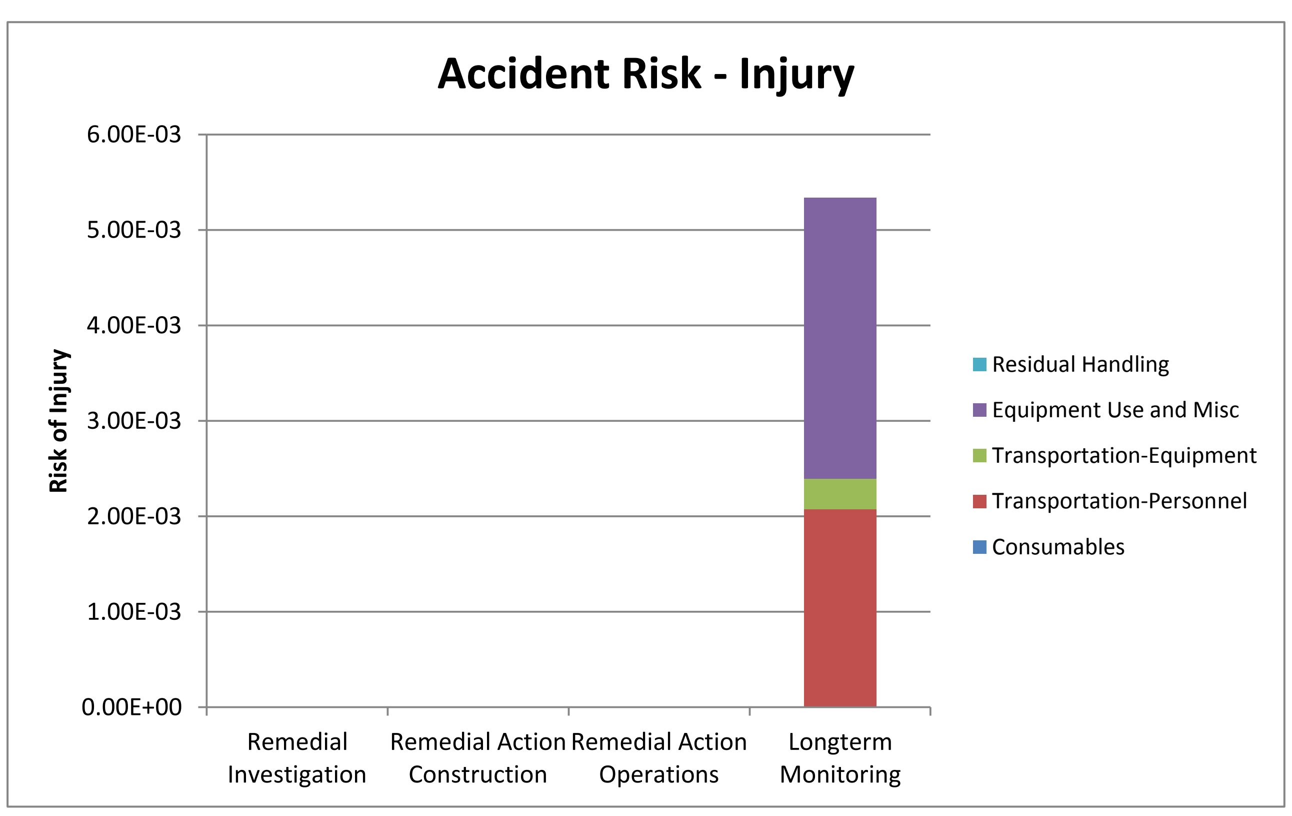


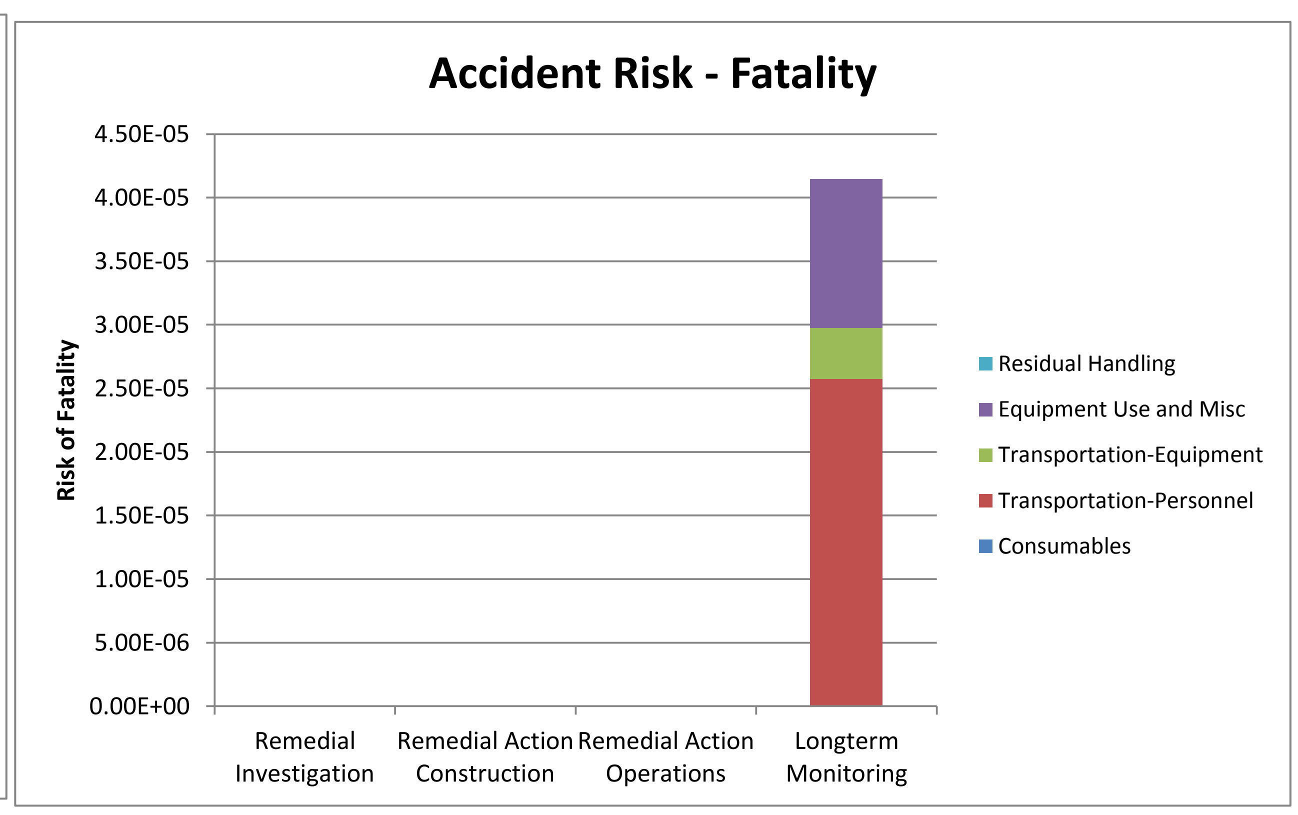












GSRx Results Alternative 2
OU7, Portsmouth Naval Shipyard
Kittery, Maine

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	Materials						Tonnes						MWhr	gal x 1000
LTM	riprap	Gravel	5.4 CY of riprap, assume gravel, 1522 kg/m3, every 5 years, through year 30	83,119.43	lbs	0.64	0.64	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	15.27	0.00
LTM	Backfill gravel	Gravel	32.6 CY of gravel, assume gravel, 1522 kg/m3, every 5 years, through year 30	501,795.10	lbs	3.87	3.87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	92.21	0.00
	Subtotal					**0.64**	**0.64**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**15.27**	**0.00**
	Transportation						**Tonnes**						**MWhr**	**gal x 1000**
	Input Into Sitewise				miles									
	Subtotal					**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**
	Construction Equipment						**Tonnes**						**MWhr**	**gal x 1000**
LTM	Loader, 4 CY	Loader, 200 HP, 4 CY (diesel)	5 days, 8 hours per day, 80% utilization, every 5 years, through year 30	64.00	hrs	2.07	2.07	0.00	0.00	1.89E-02	3.92E-03	2.27E-03	7.56	
LTM	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	6 days, 8 hours per day, 80% utilization, every 5 years, through year 30	64.00	hrs	6.20	6.20	0.00	0.00	3.90E-02	1.15E-02	3.71E-03	28.16	
	Subtotal					**2.07**	**2.07**	**0.00E+00**	**0.00E+00**	**1.89E-02**	**3.92E-03**	**2.27E-03**	**7.56**	**0**
	Operating Consumption						**Tonnes**						**MWhr**	**gal x 1000**
	Input Into Sitewise													0
						0	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	**0**
				Total		**3**	**3**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**23**	**0**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
		Tonnes						MMBTU	gal
RI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LTM	12.78	12.78	0.00	0.00	0.06	0.02	0.01	488.61	0.00

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

SiteWise Results Alternative 3
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

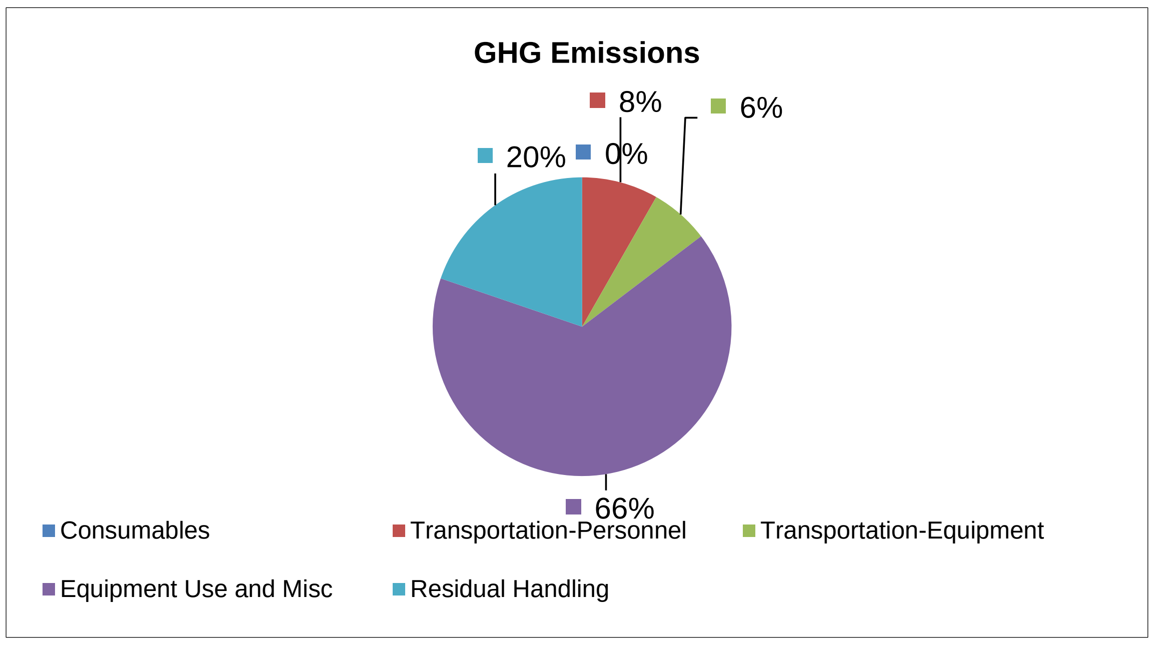
Sustainable Remediation - Environmental Footprint Summary
Alternative 3

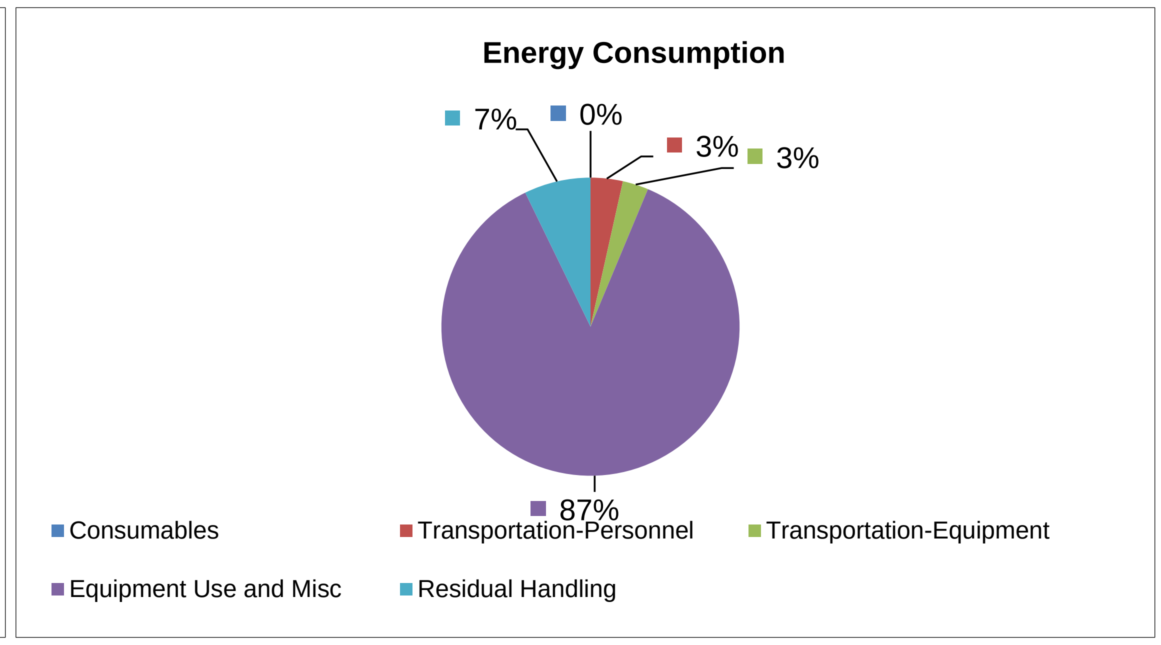
Phase	Activities	GHG Emissions	Total energy Used	Water Consumption	NOx emissions	SOx Emissions	PM10 Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton	MMBTU	gallons	metric ton	metric ton	metric ton		
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	2.97	3.7E+01	NA	1.1E-03	3.9E-05	2.2E-04	6.1E-05	4.9E-03
	Transportation-Equipment	2.30	3.0E+01	NA	7.2E-04	1.3E-05	6.4E-05	5.7E-06	4.6E-04
	Equipment Use and Misc	23.58	9.3E+02	2.1E+03	5.6E-02	3.0E-02	2.2E-01	1.5E-05	3.8E-03
	Residual Handling	7.11	7.7E+01	NA	2.0E-02	1.0E-02	5.5E-02	1.1E-05	9.0E-04
	Sub-Total	35.96	1.07E+03	2.09E+03	7.77E-02	4.07E-02	2.73E-01	9.30E-05	1.01E-02
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.84	1.1E+01	NA	3.1E-04	1.1E-05	6.3E-05	1.7E-05	1.4E-03
	Transportation-Equipment	1.63	2.1E+01	NA	5.1E-04	9.1E-06	4.6E-05	4.0E-06	3.2E-04
	Equipment Use and Misc	12.07	4.3E+02	0.0E+00	5.8E-02	1.5E-02	6.0E-03	1.2E-05	2.9E-03
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	14.54	4.63E+02	0.00E+00	5.87E-02	1.54E-02	6.09E-03	3.29E-05	4.65E-03
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.69	8.6E+00	NA	2.5E-04	8.9E-06	5.1E-05	1.4E-05	1.1E-03
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.69	8.63E+00	0.00E+00	2.54E-04	8.94E-06	5.15E-05	1.40E-05	1.13E-03
Total		**5.1E+01**	**1.5E+03**	**2.1E+03**	**1.4E-01**	**5.6E-02**	**2.8E-01**	**1.4E-04**	**1.6E-02**

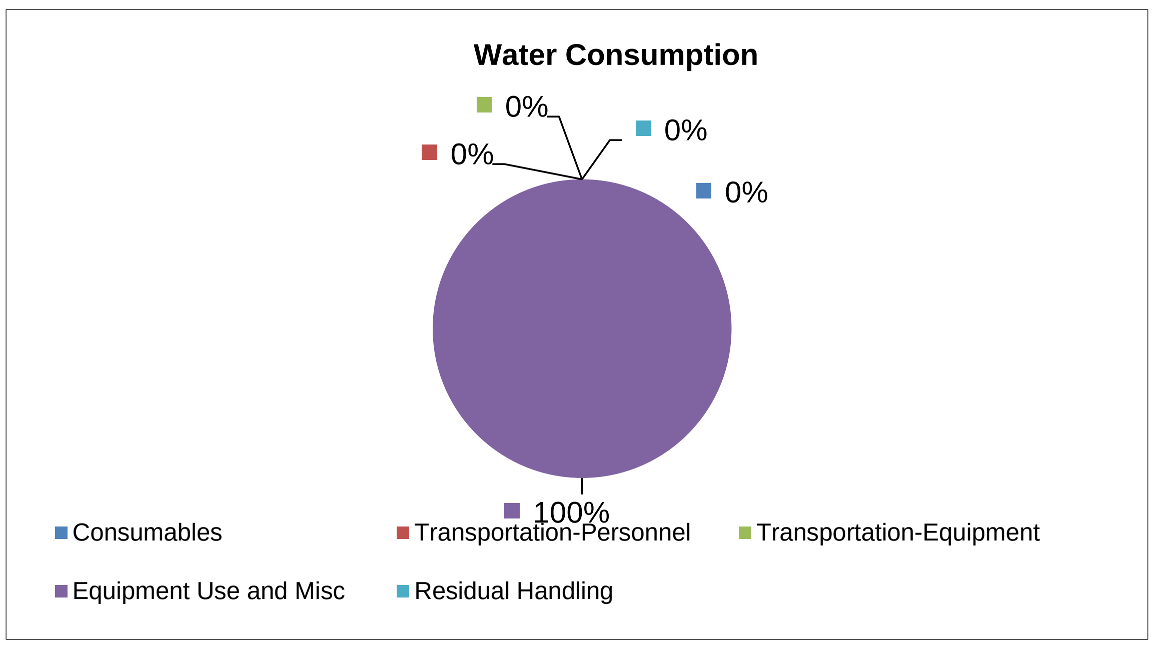
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space	Hazardous Waste Landfill Space	Topsoil Consumption	Costing	Lost Hours - Injury
	tons	tons	cubic yards	$	
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	2.7E+02	2.9E+01	0.0E+00	0	8.1E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	3.7E-02
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	9.0E-03
Total	**2.7E+02**	**2.9E+01**	**0.0E+00**	**$0**	**1.3E-01**

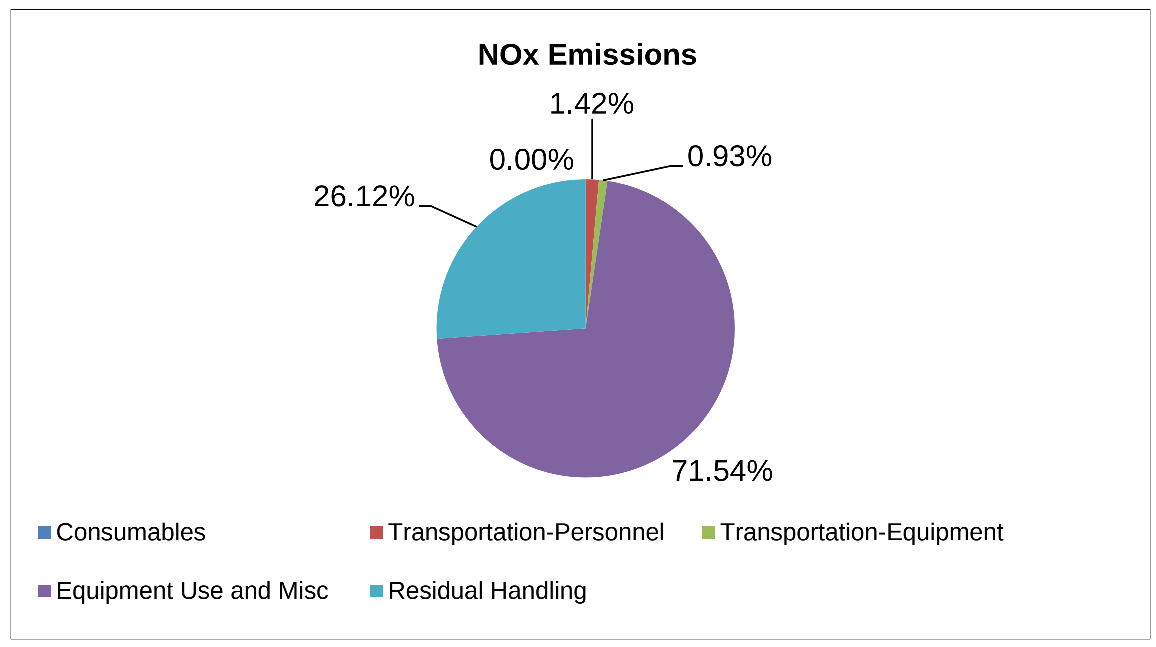
Total Cost with Footprint Reduction
$0

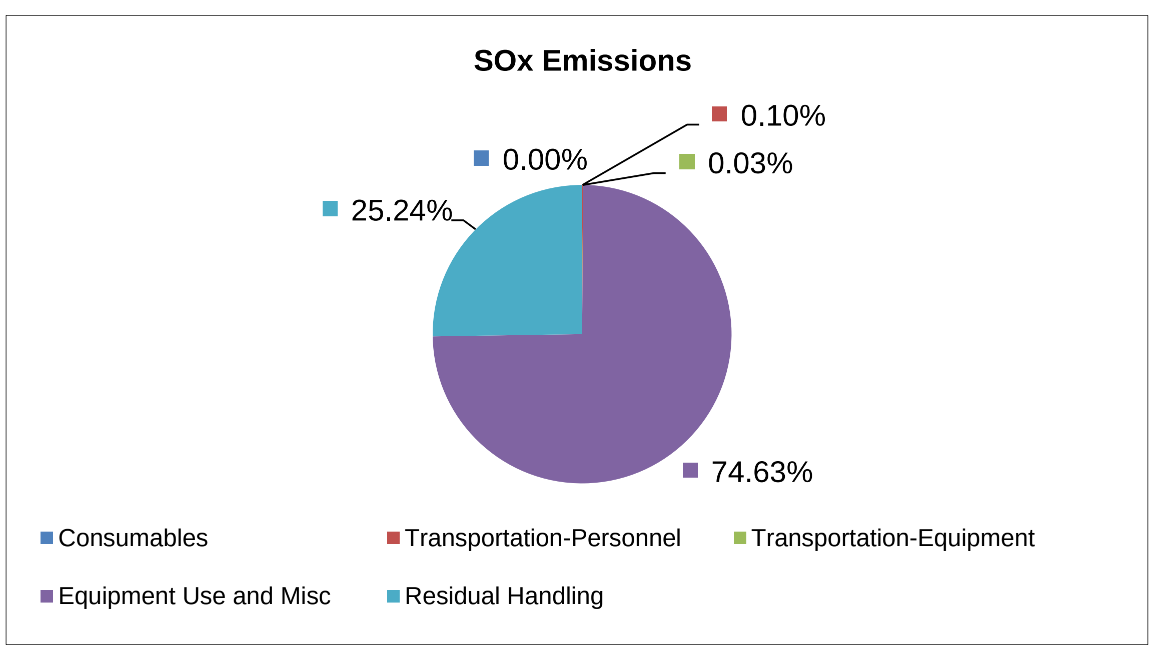
SiteWise Results Alternative 3
Remedial Action Construction Stage
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

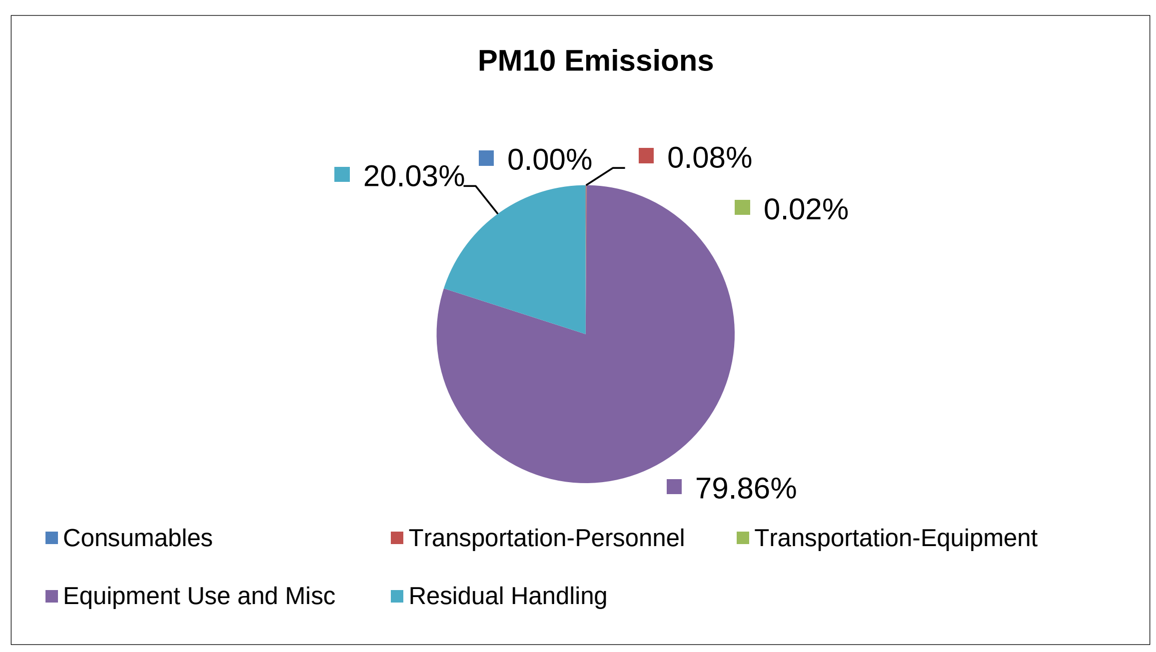


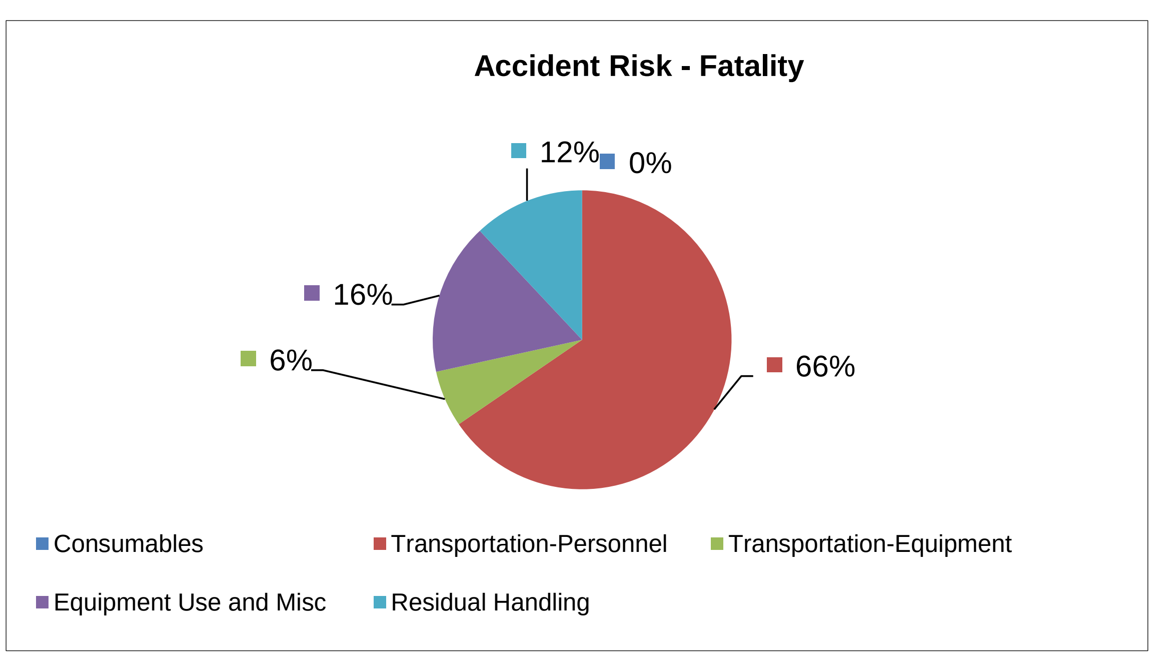


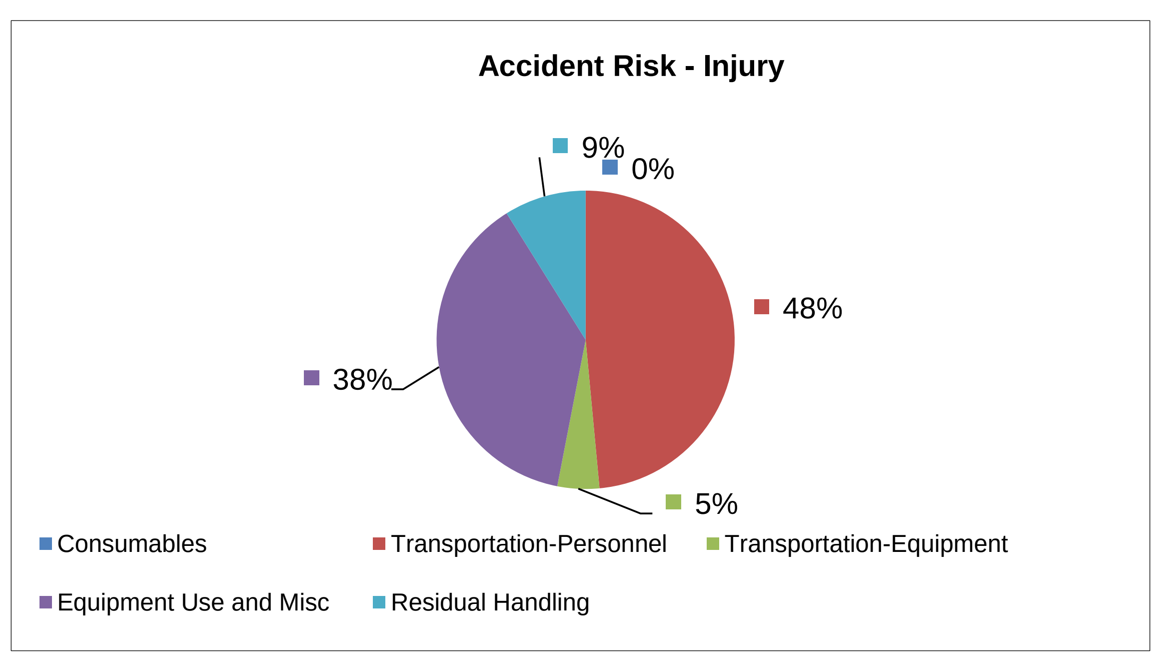




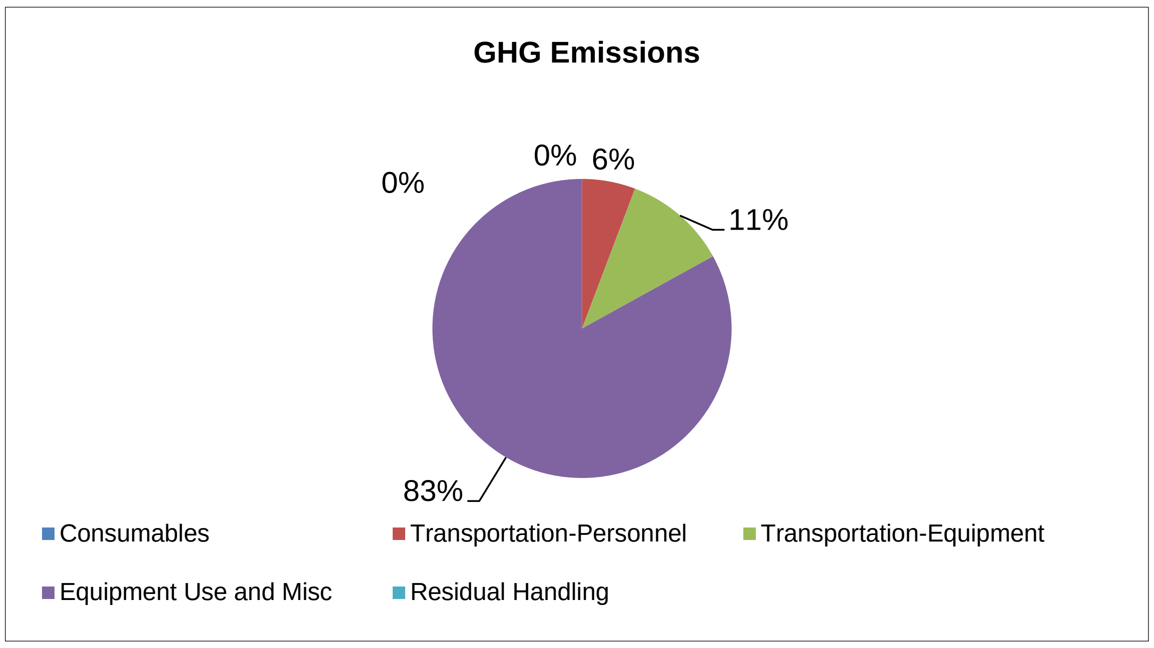


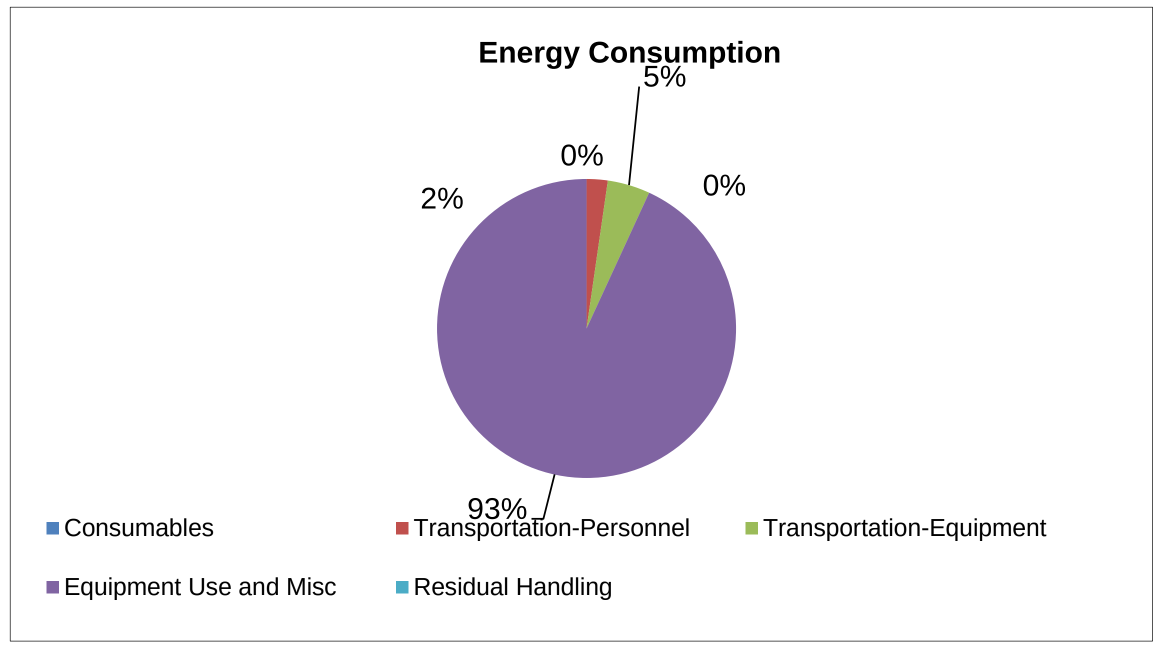


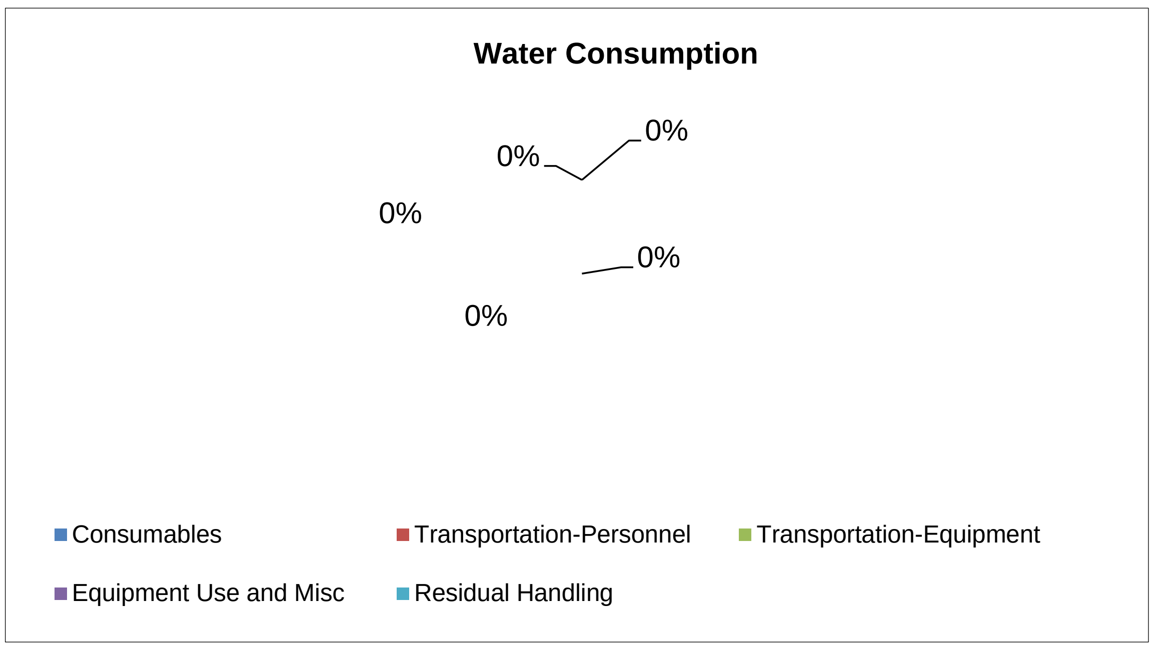


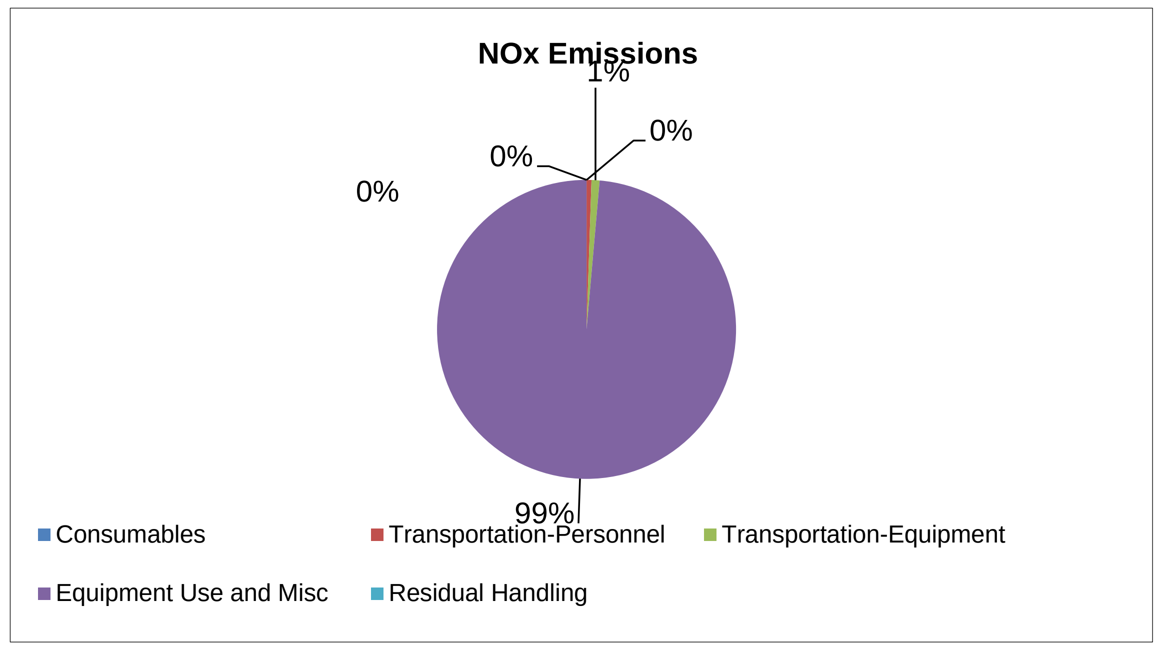


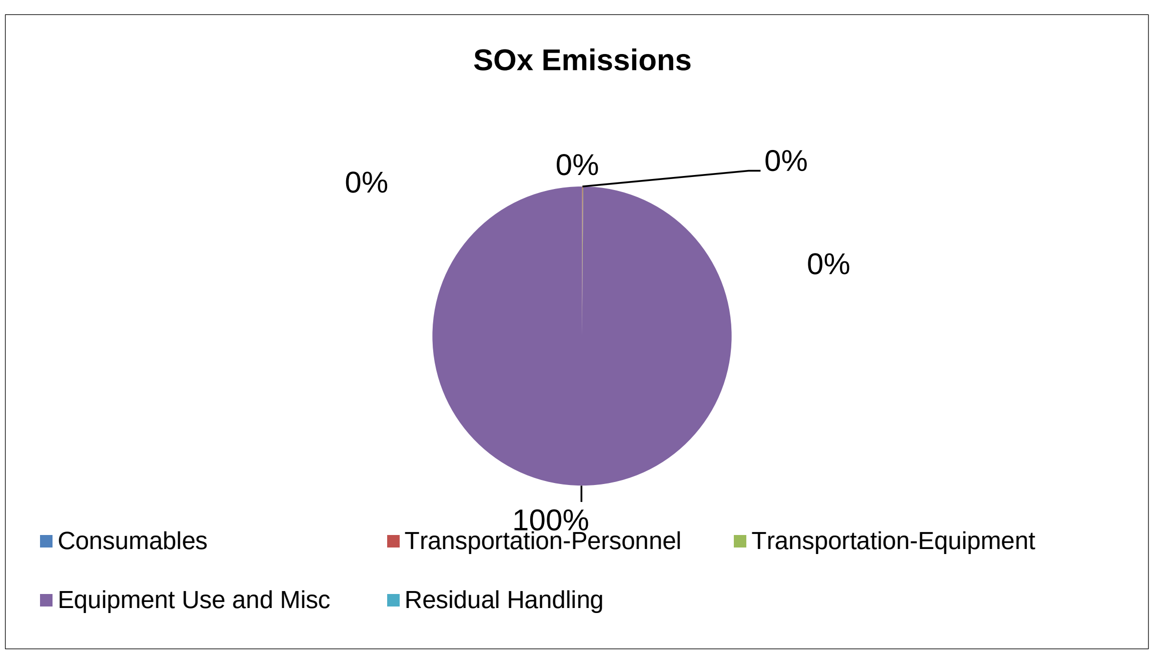
SiteWise Results Alternative 3
Remedial Action Operations Stage
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

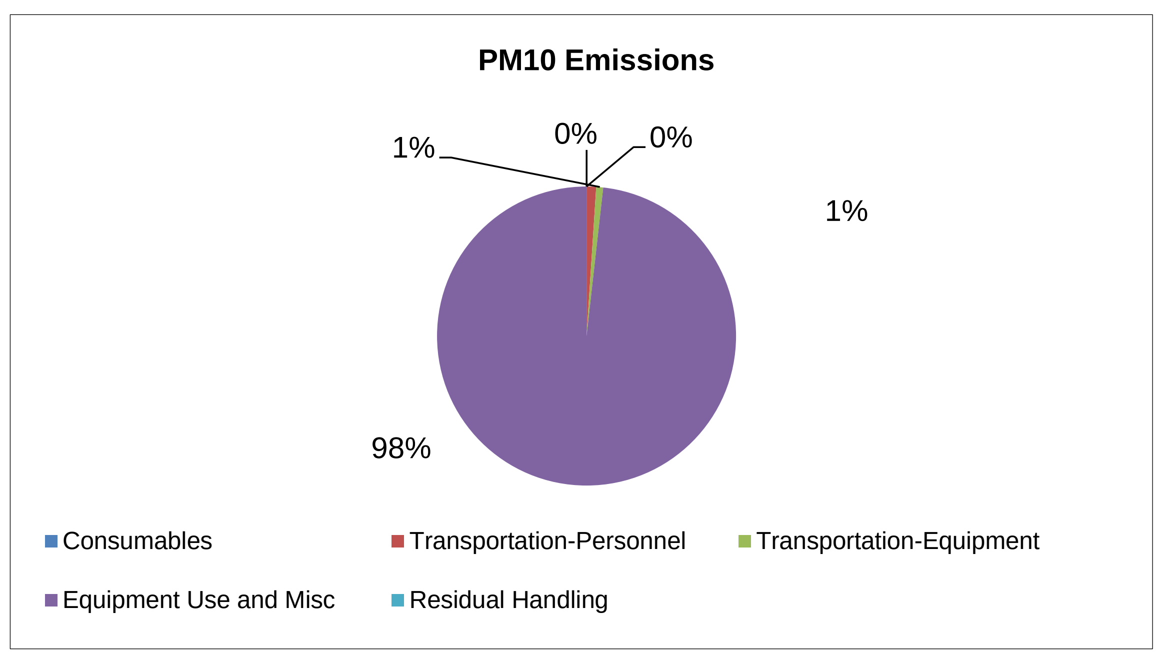


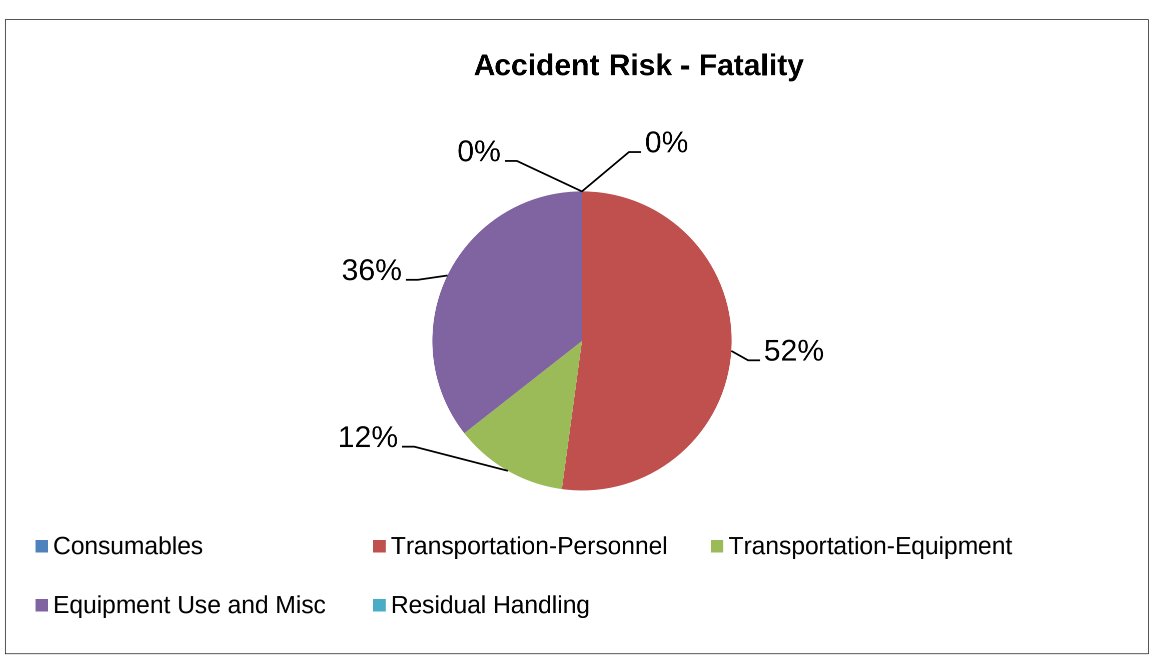


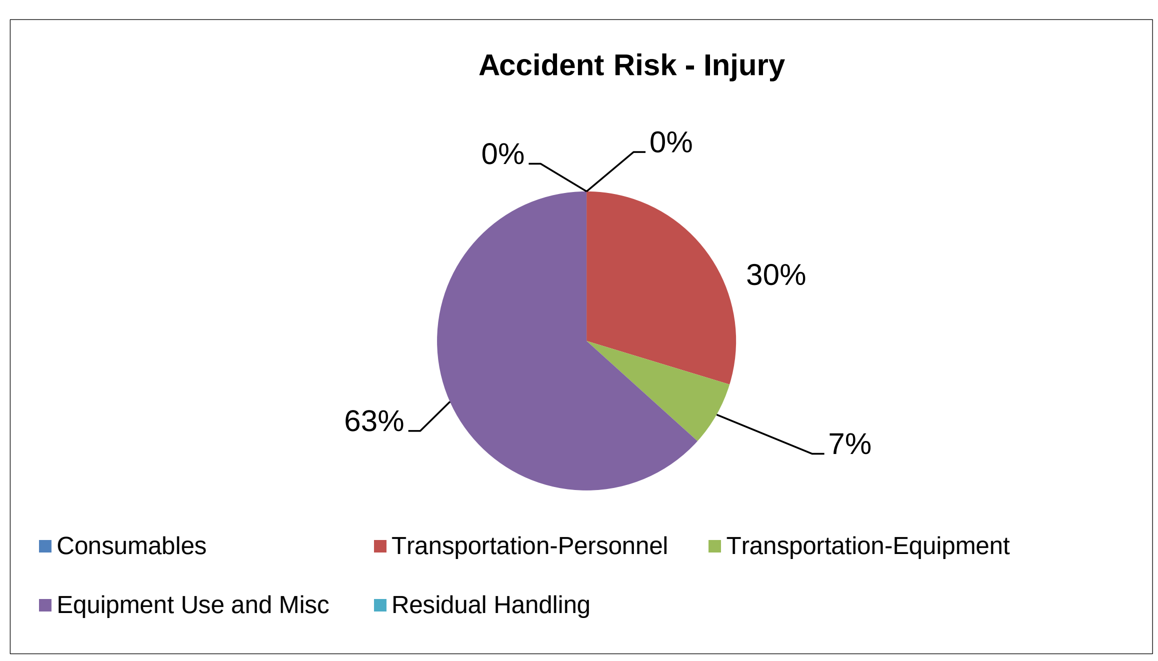




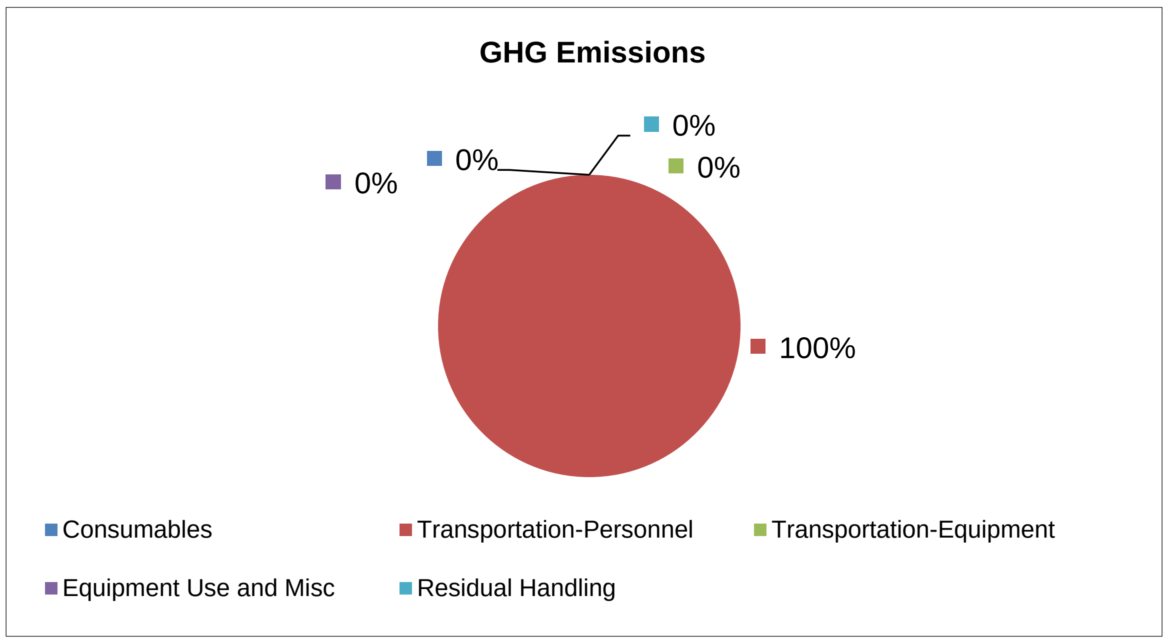


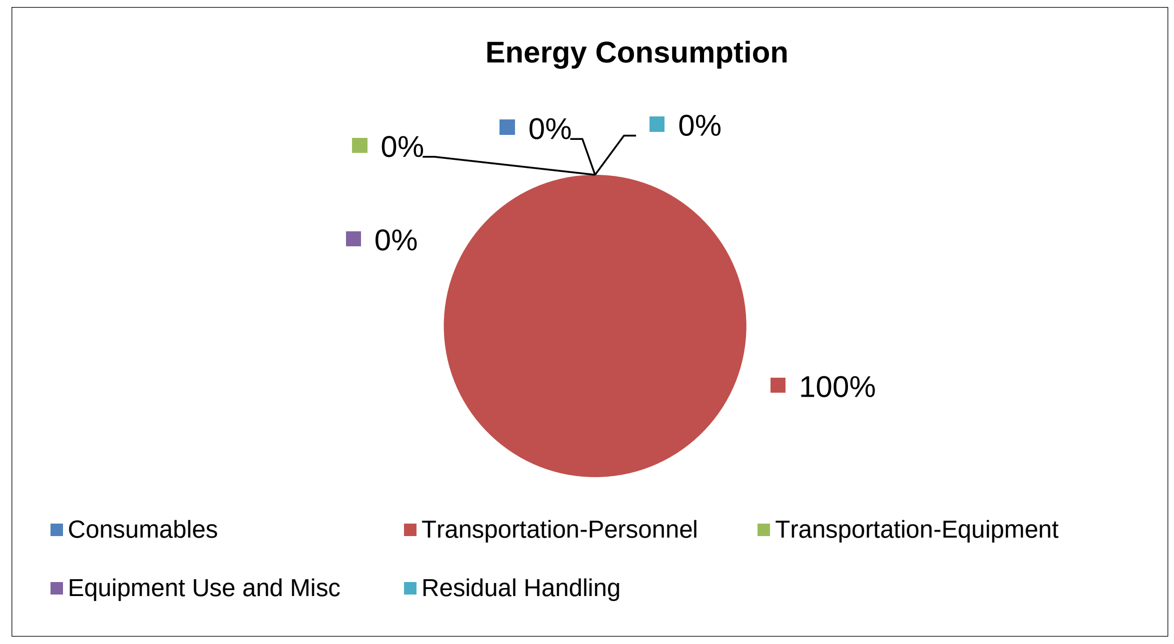


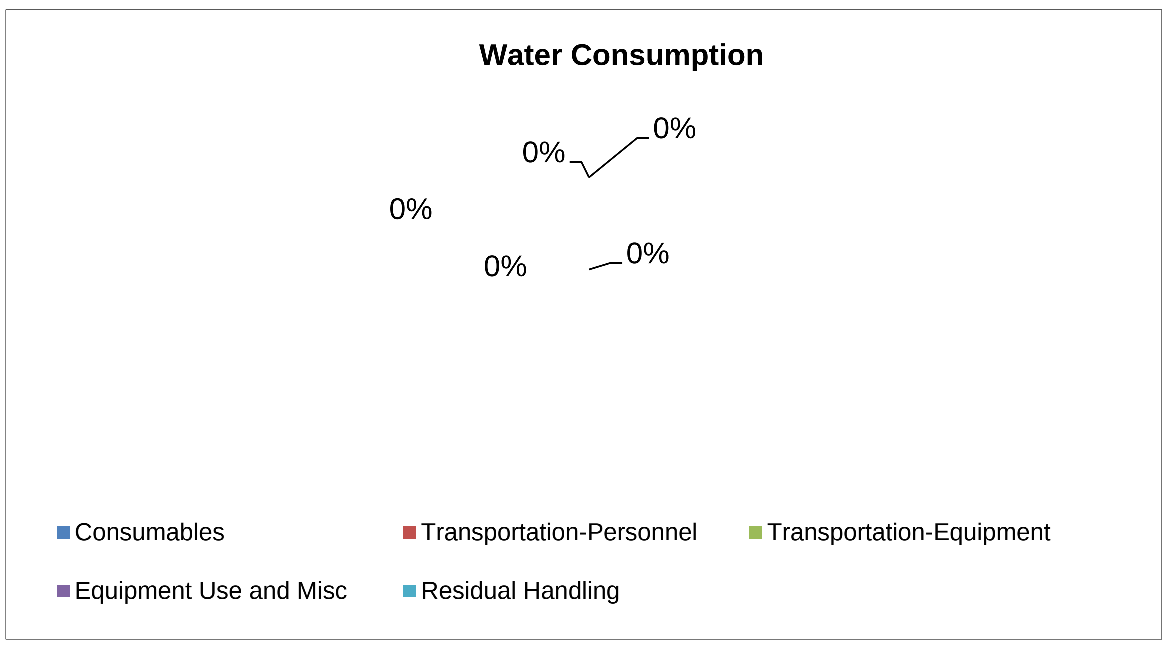


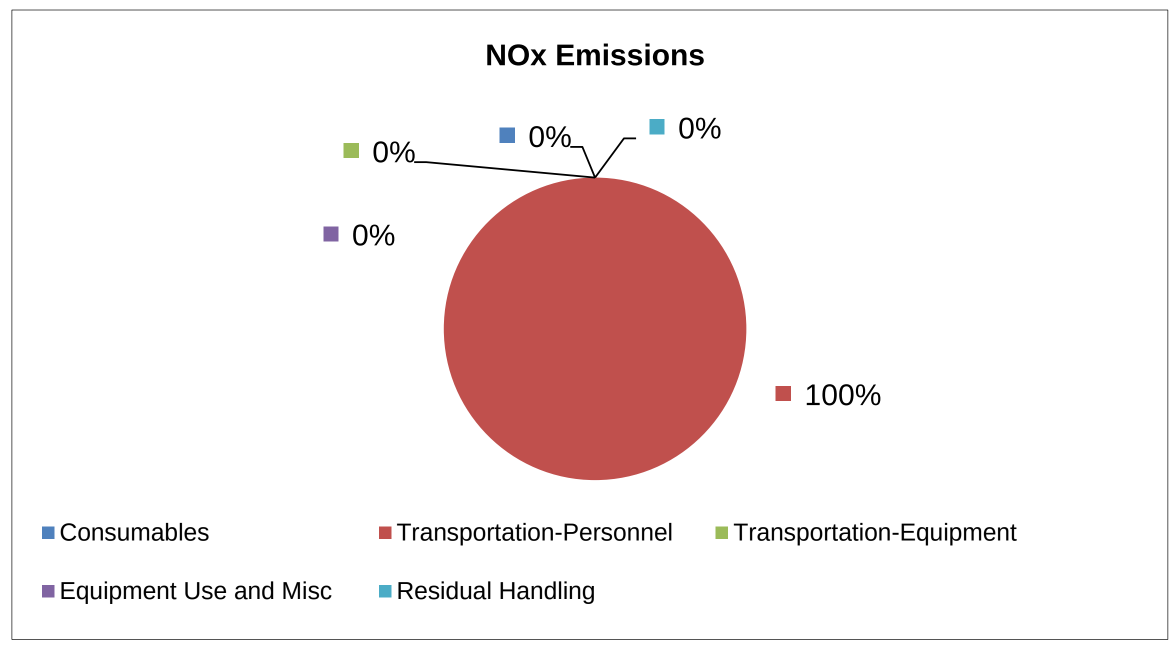


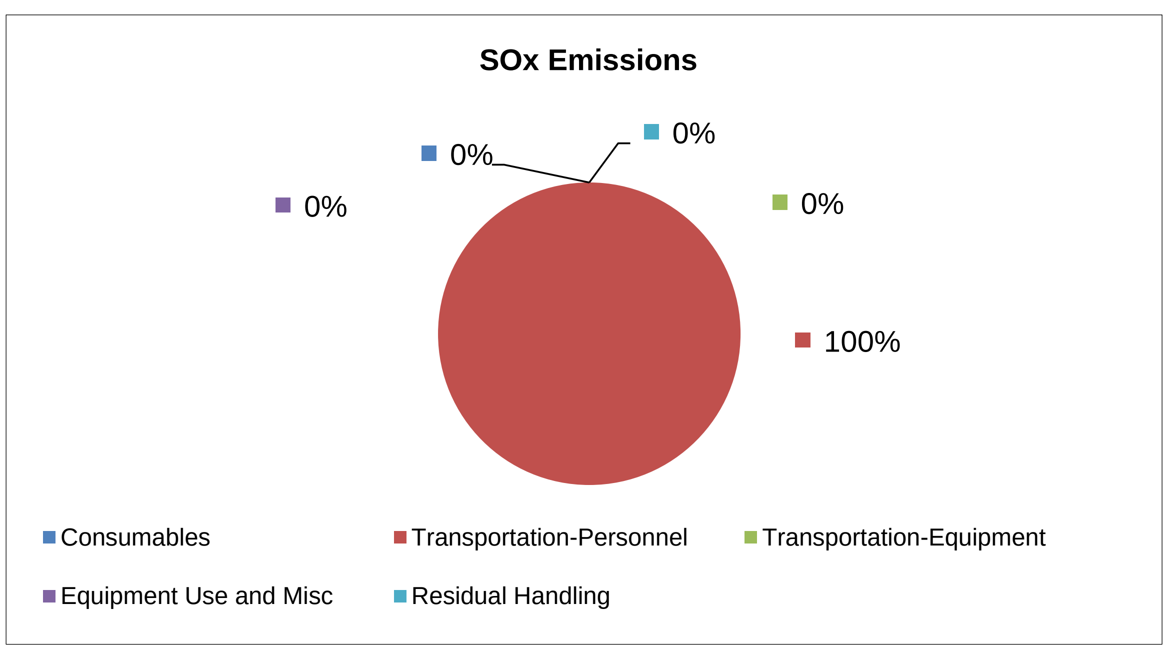
SiteWise Results Alternative 3
Long Term Management Stage
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine

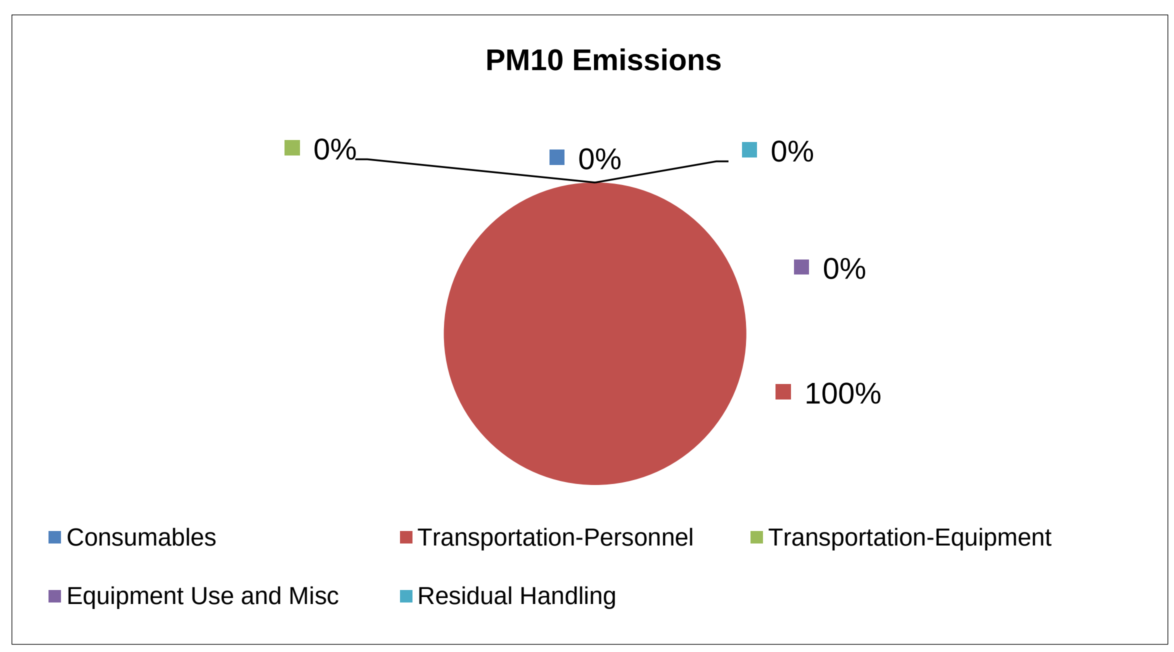


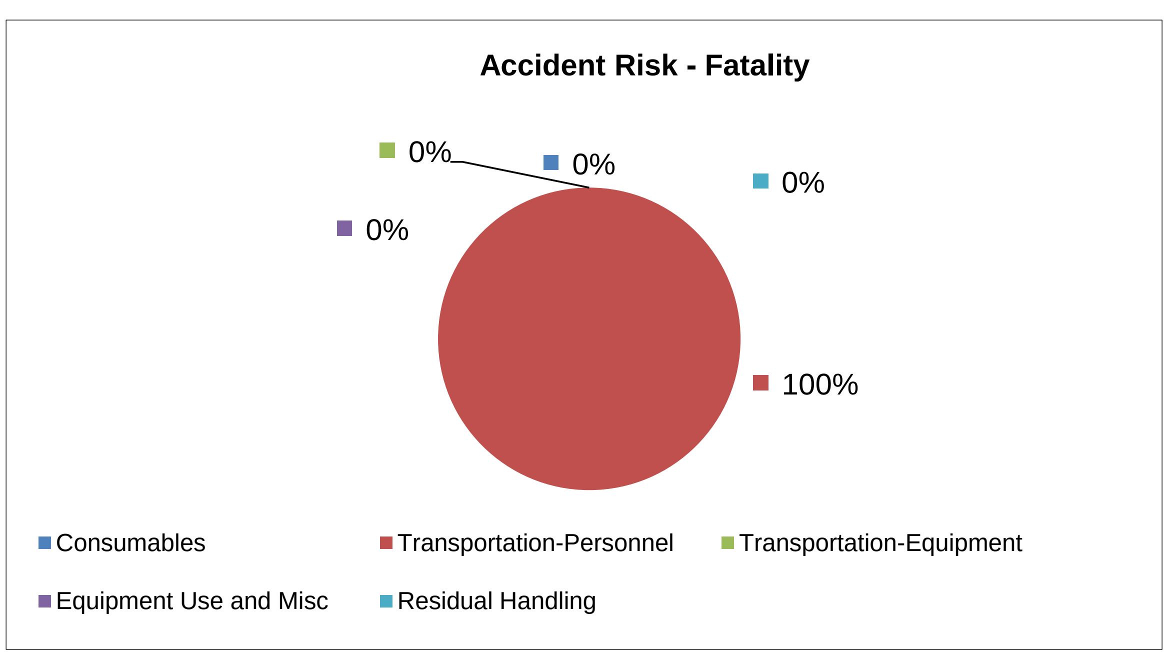


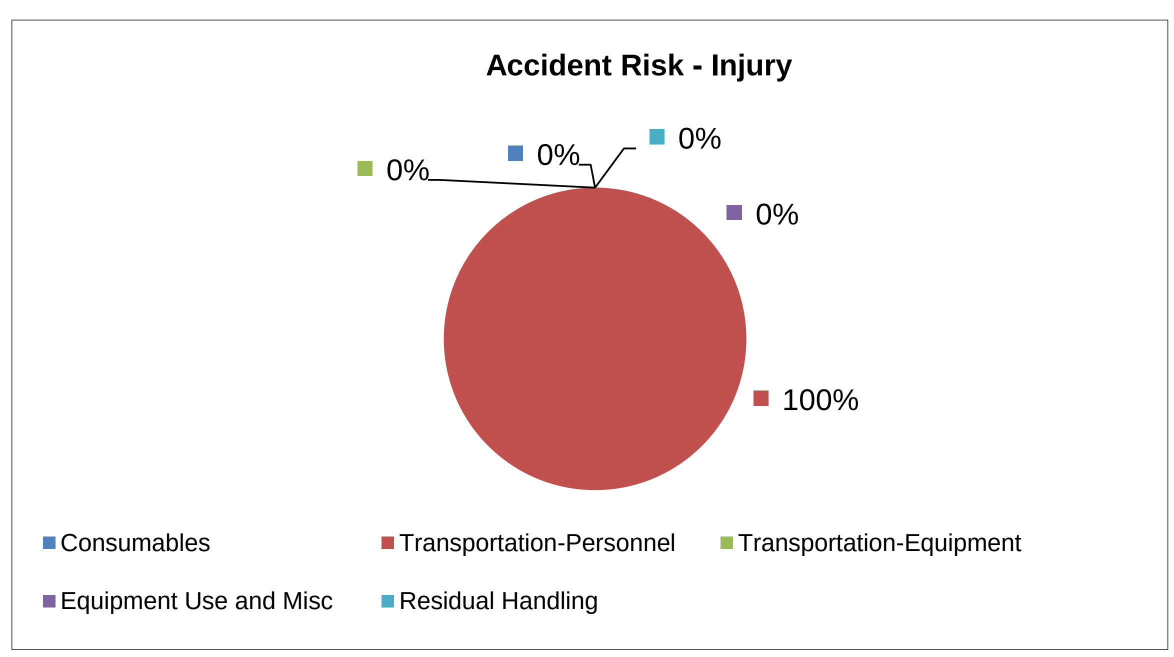


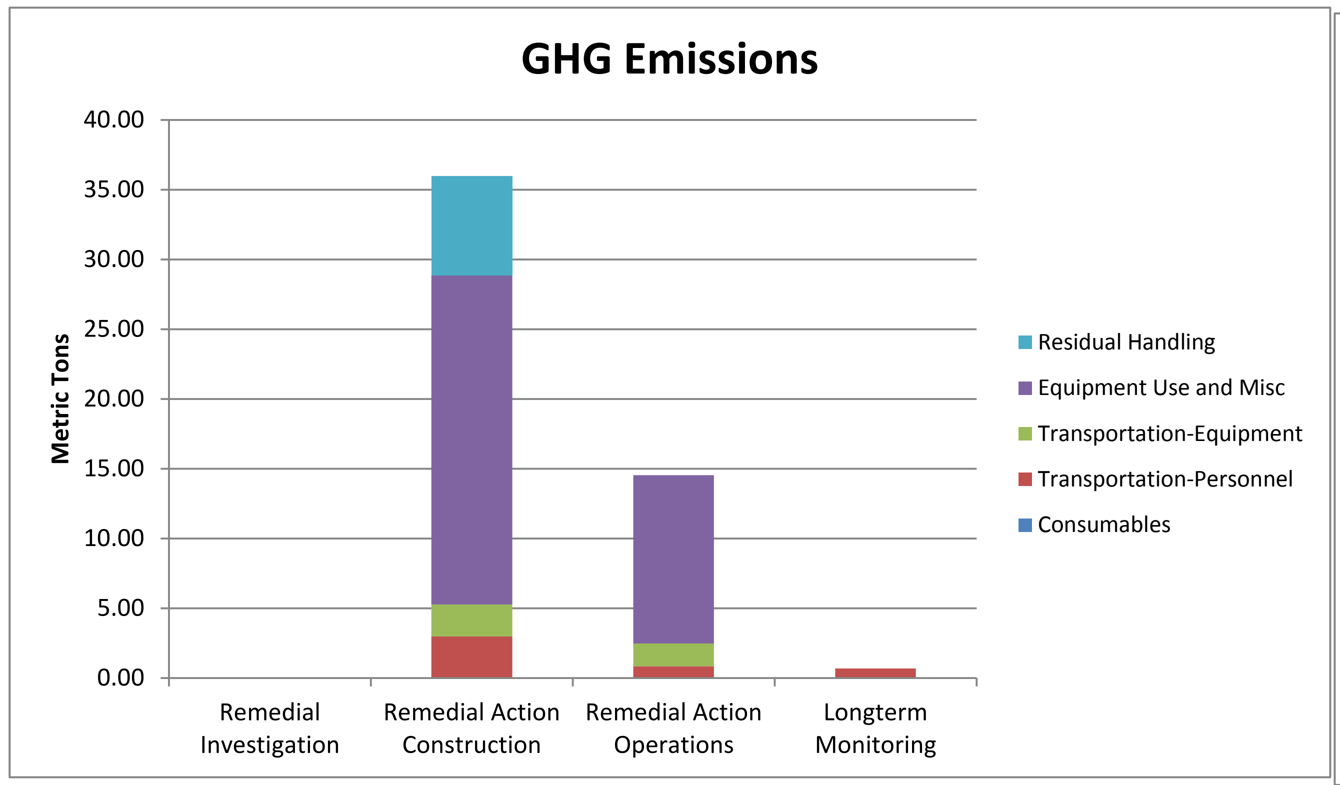


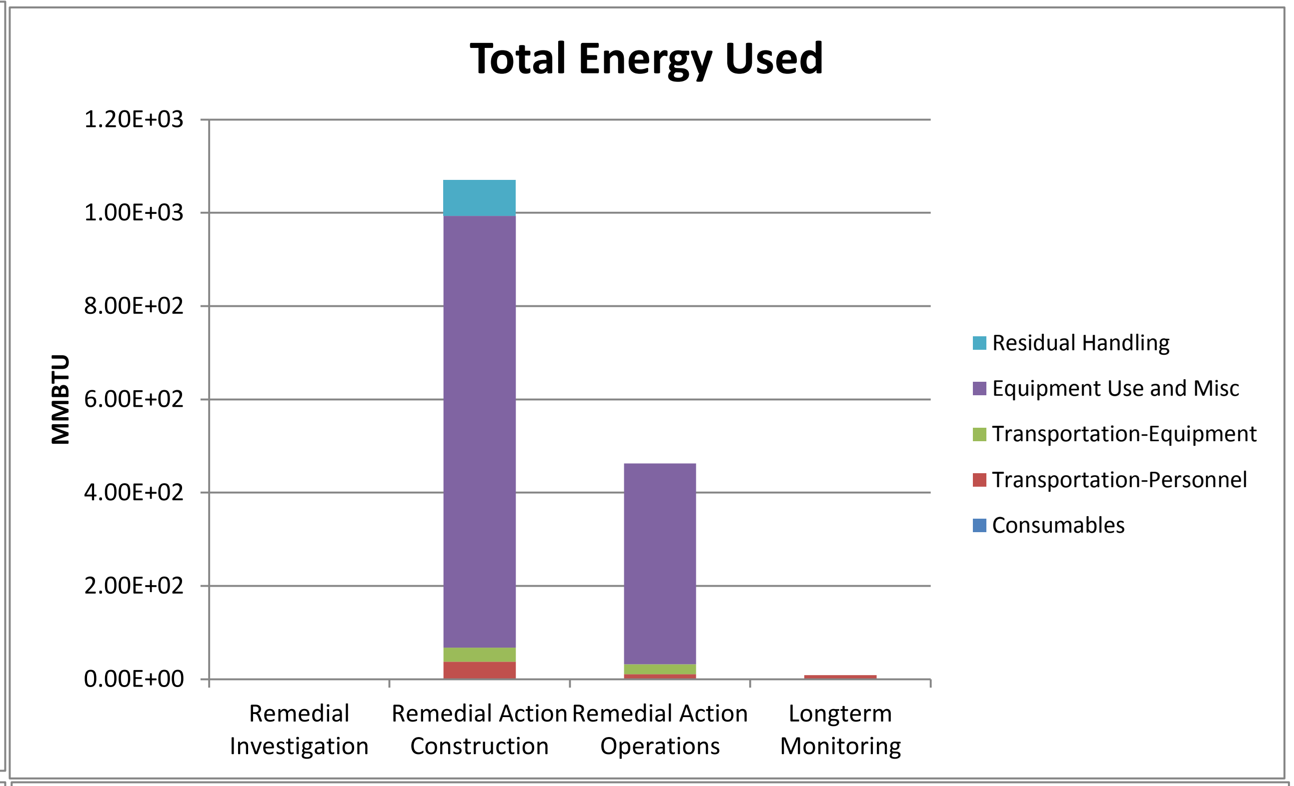


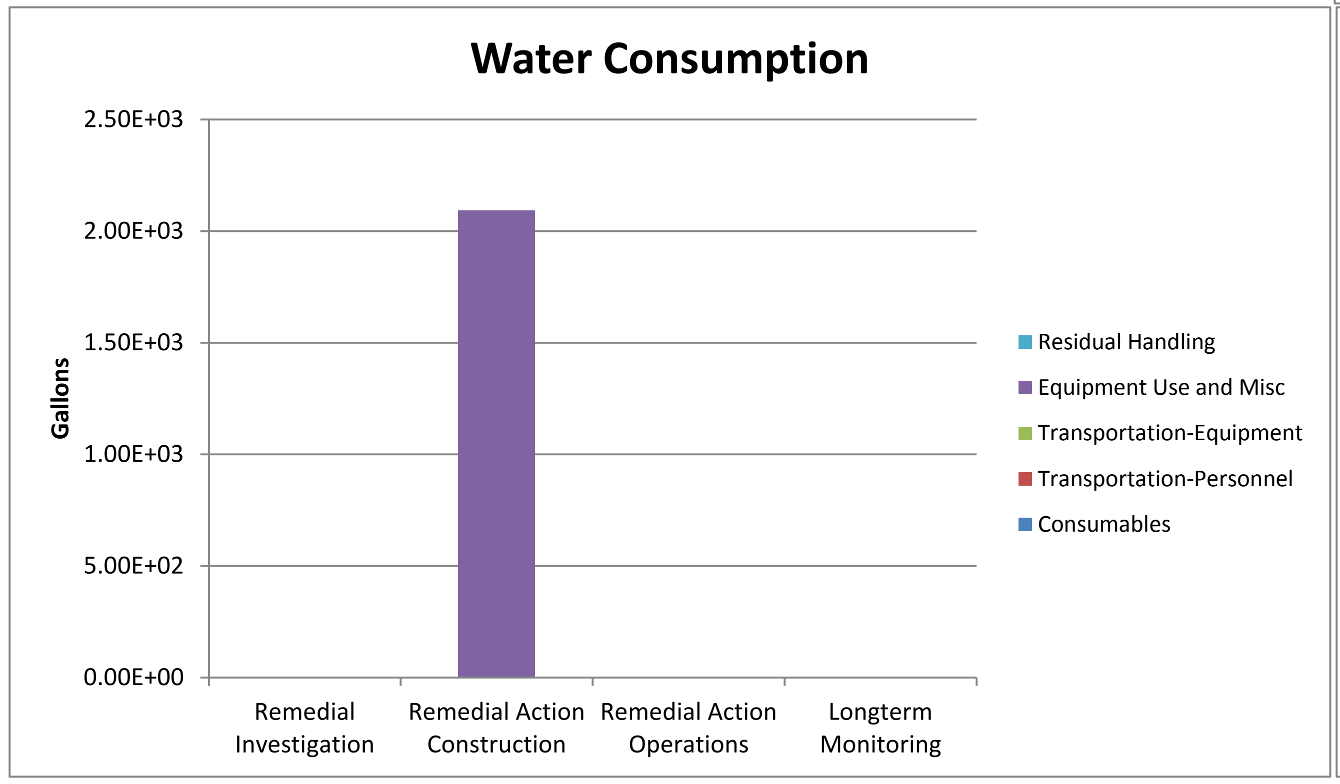


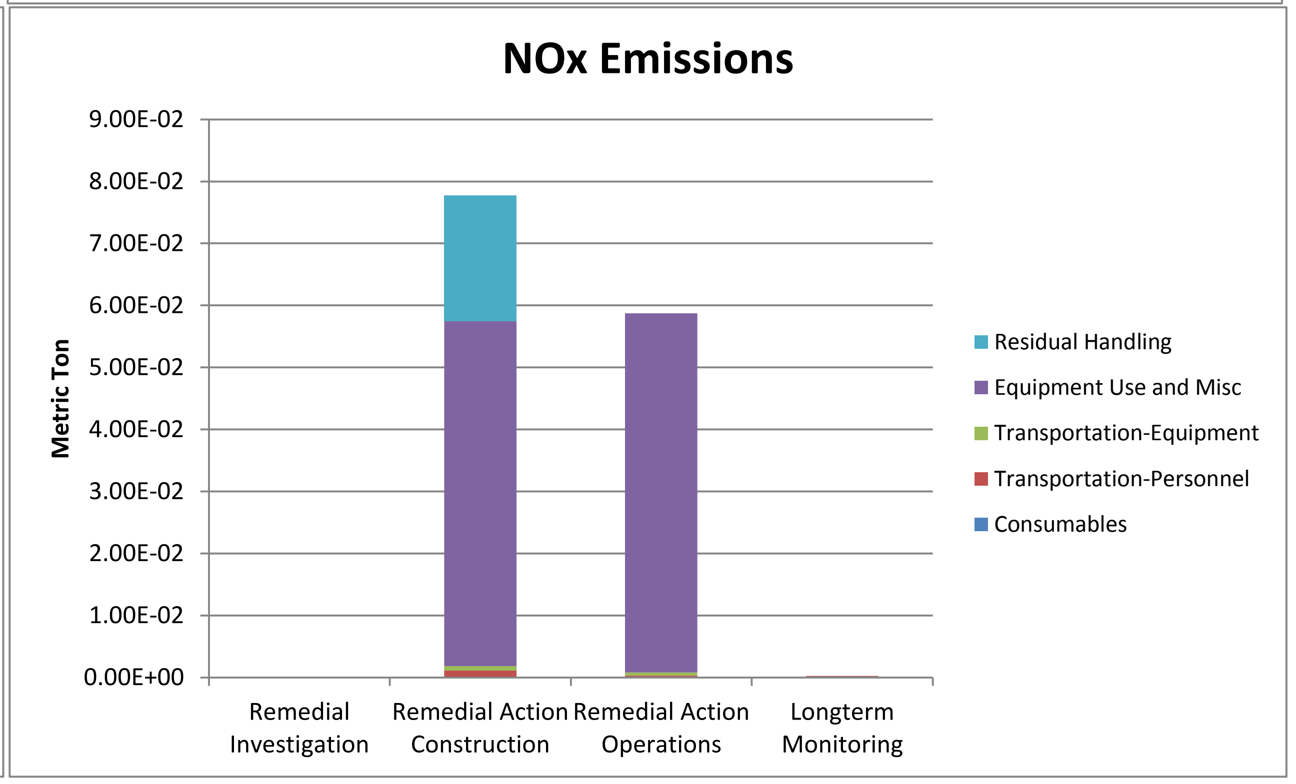


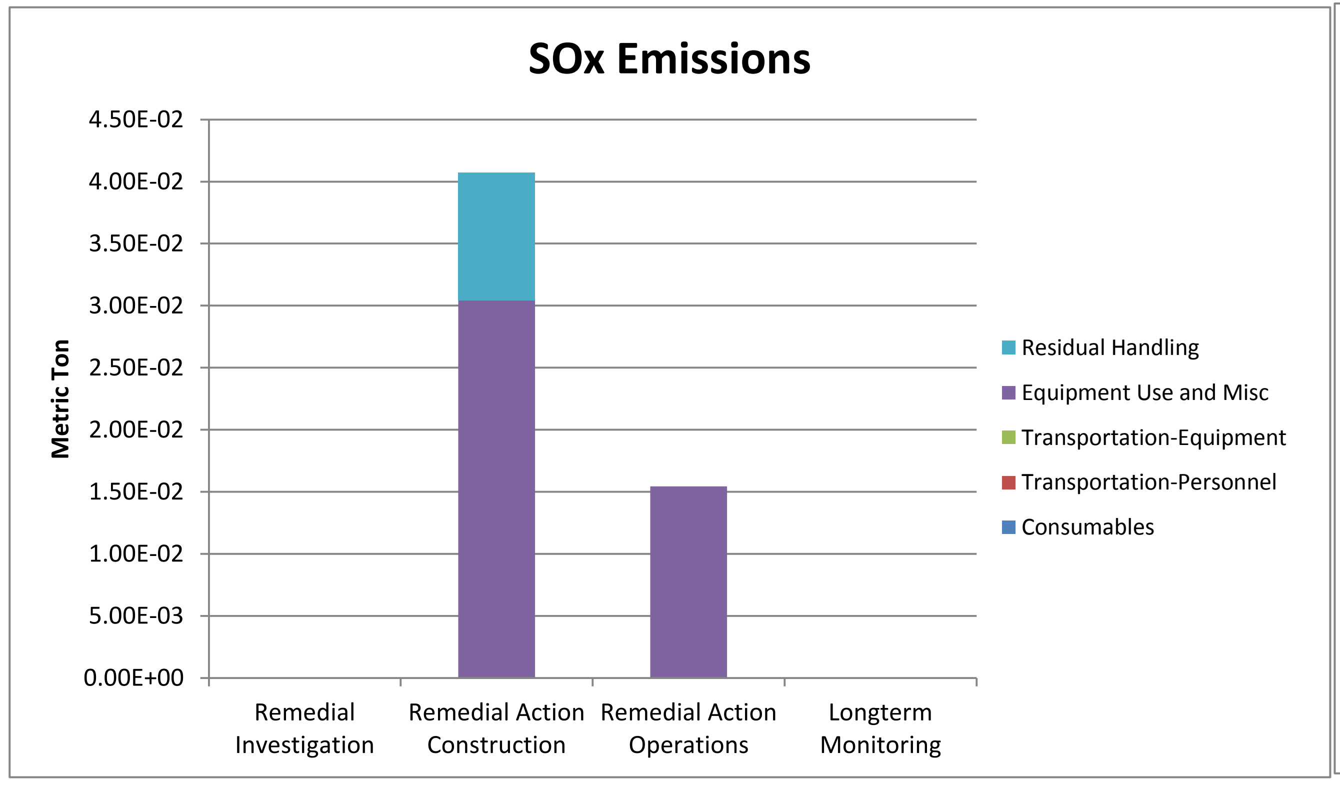


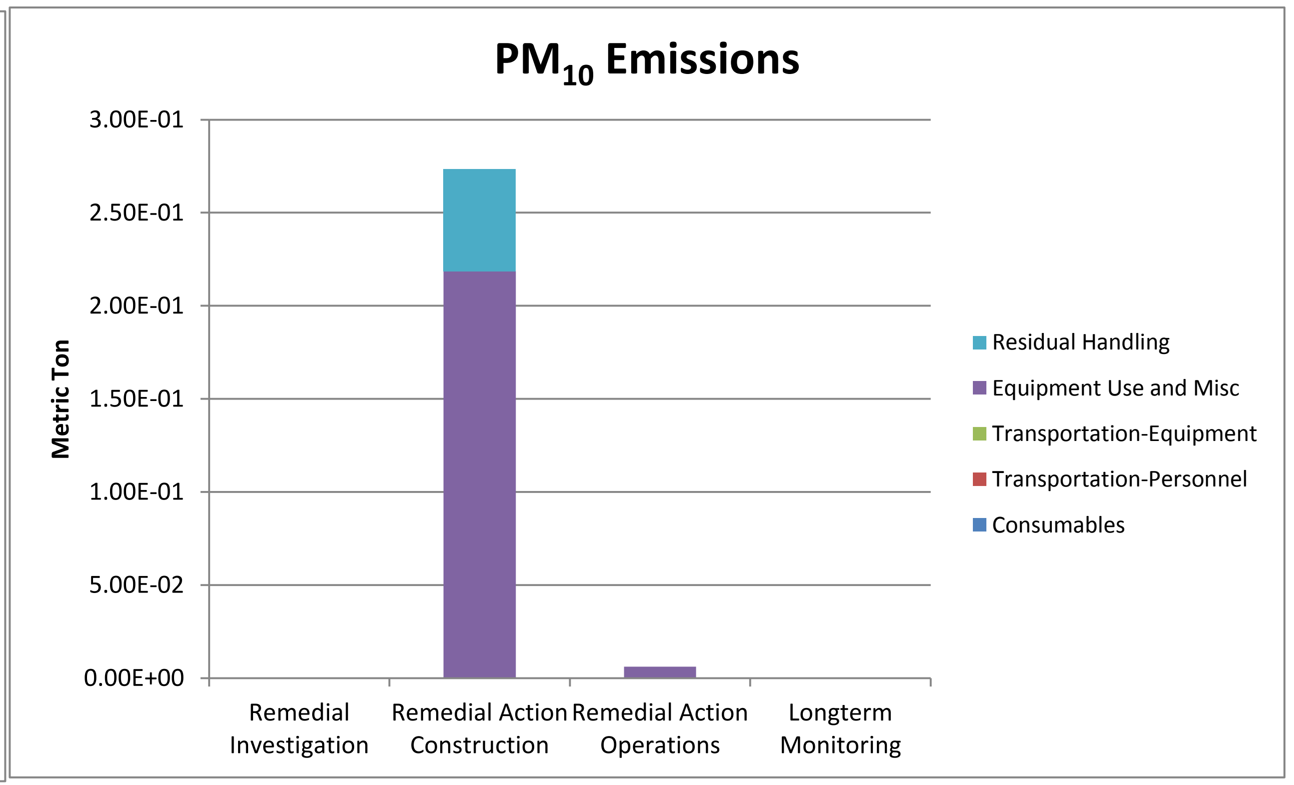

GHG Emissions
Metric Tons
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables


Total Energy Used
MMBTU
1.20E+03
1.00E+03
8.00E+02
6.00E+02
4.00E+02
2.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

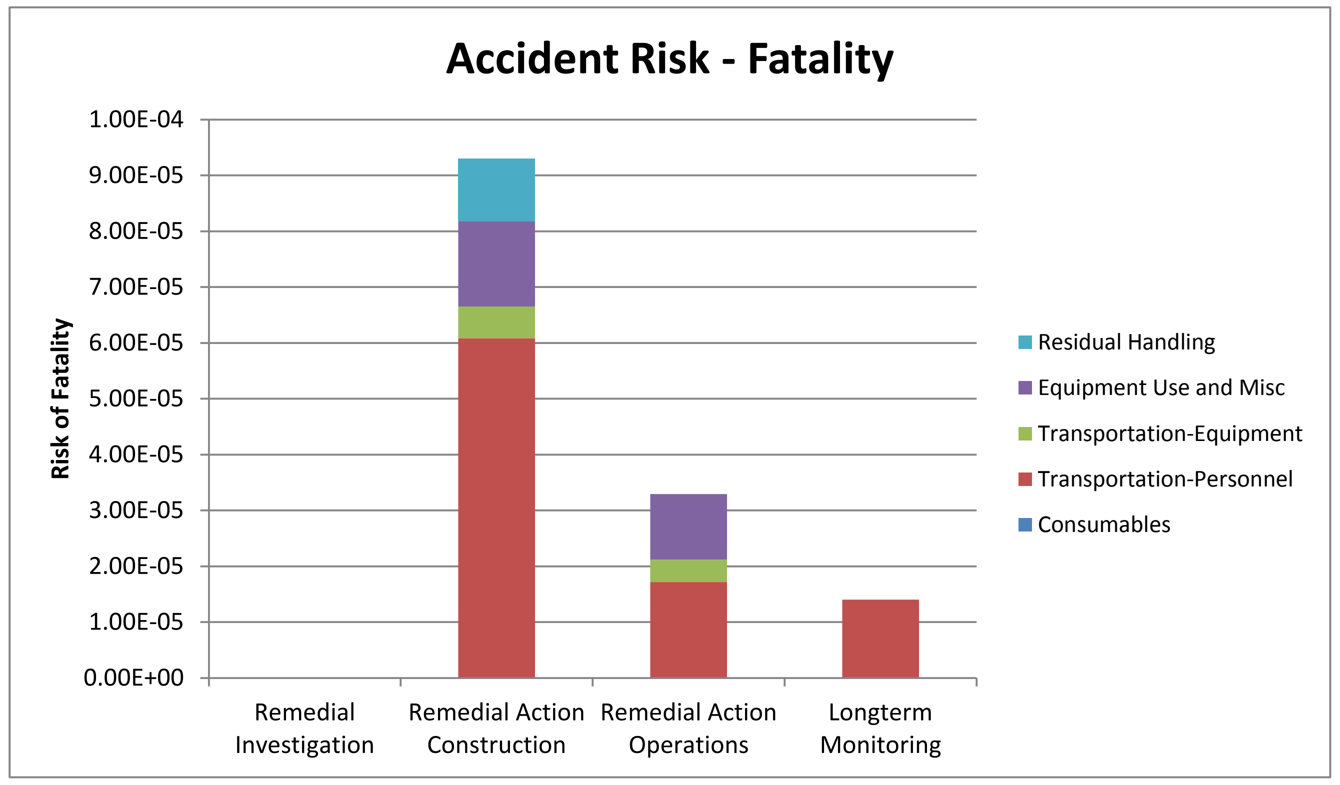

Water Consumption
Gallons
2.50E+03
2.00E+03
1.50E+03
1.00E+03
5.00E+02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

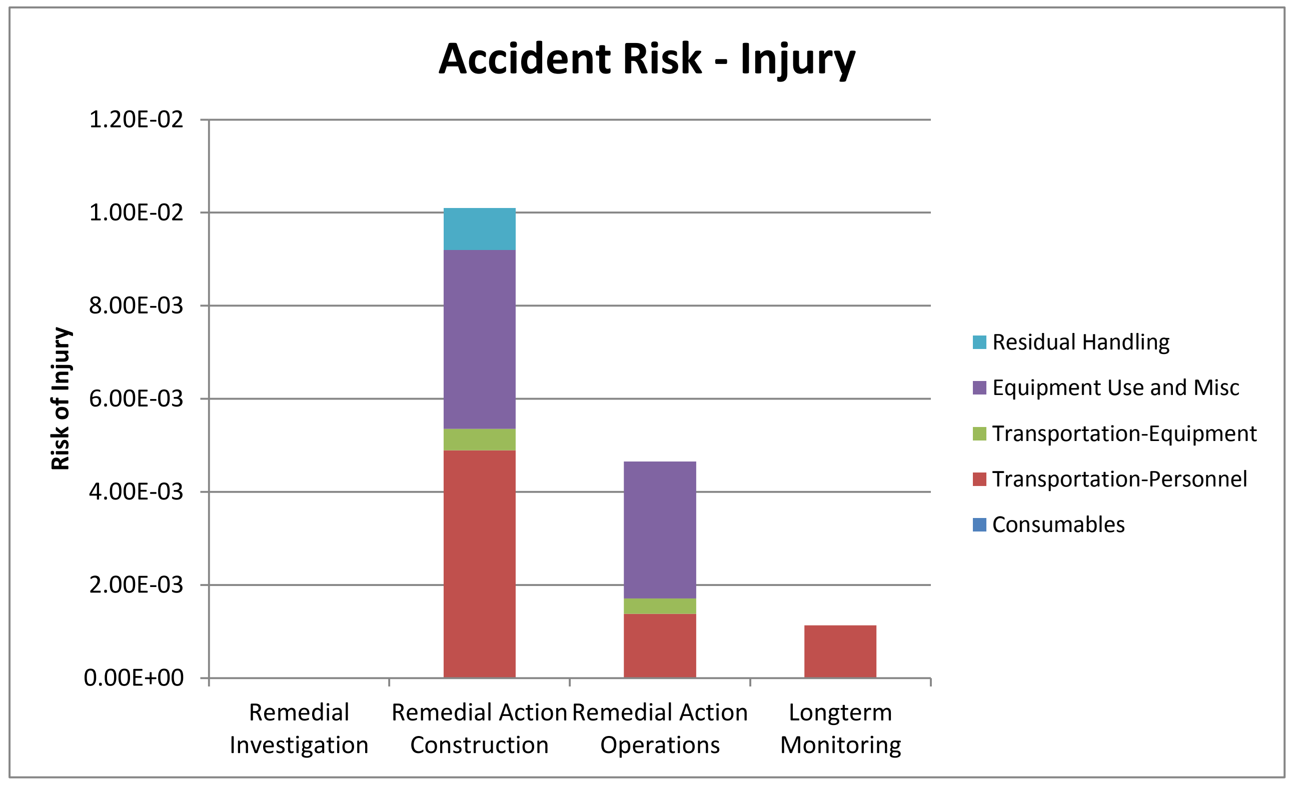

NOx Emissions
Metric Ton
9.00E-02
8.00E-02
7.00E-02
6.00E-02
5.00E-02
4.00E-02
3.00E-02
2.00E-02
1.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

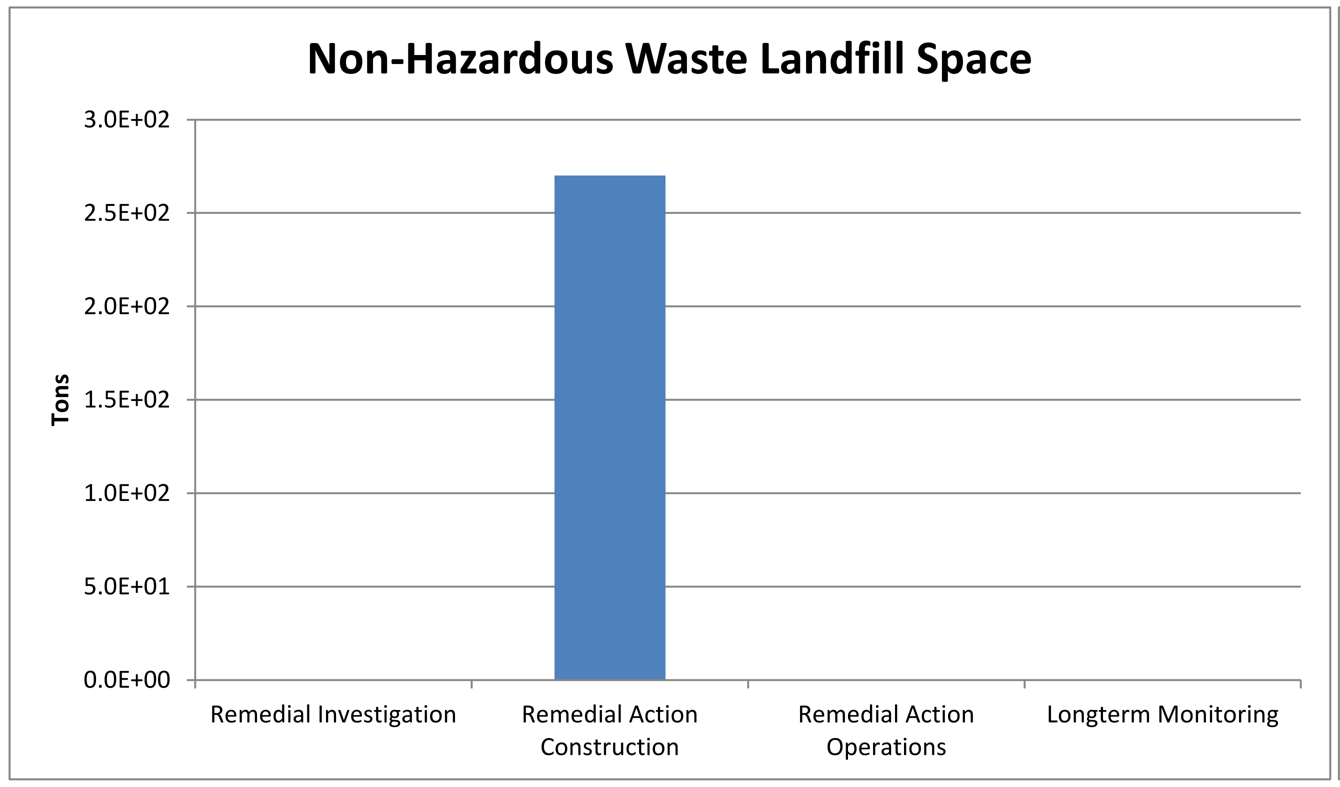

SOx Emissions
Metric Ton
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

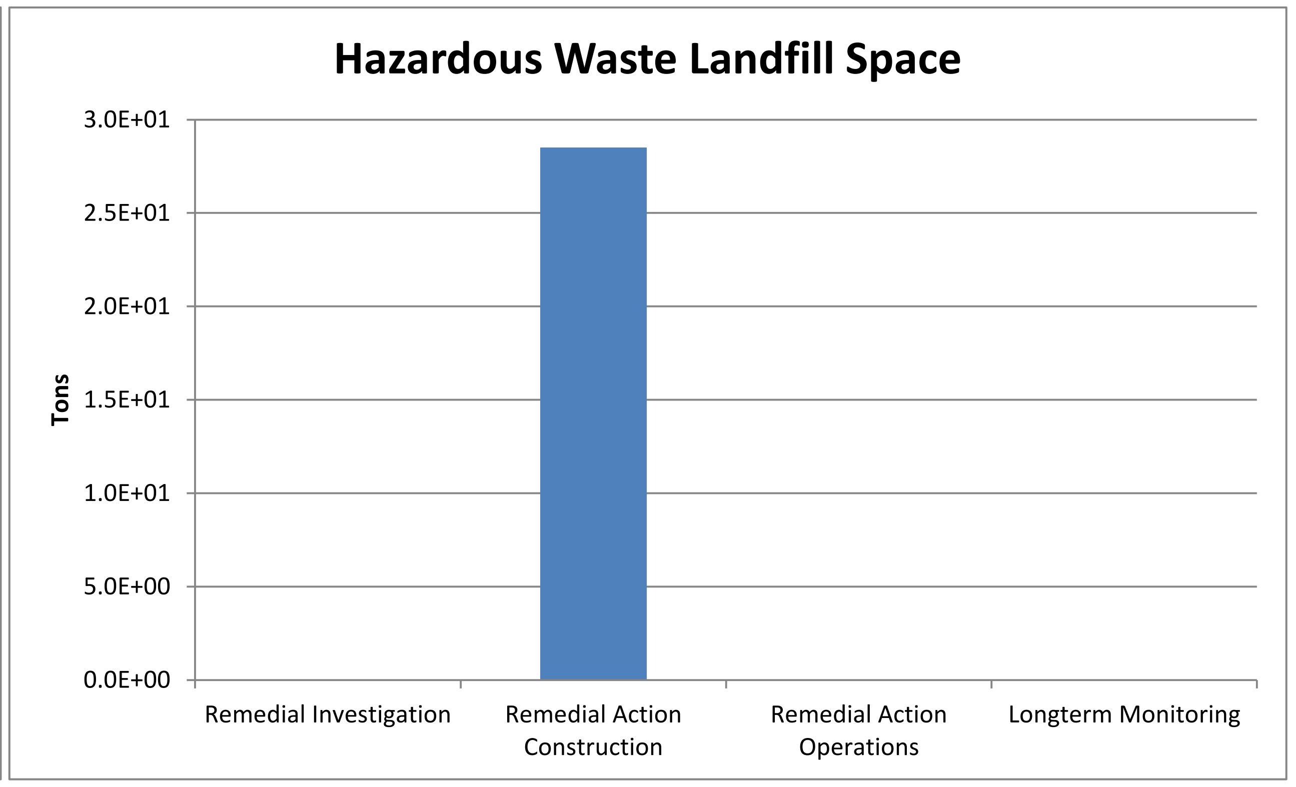

PM_{10} Emissions
Metric Ton
3.00E-01
2.50E-01
2.00E-01
1.50E-01
1.00E-01
5.00E-02
0.00E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables

SiteWise Results Alternative 3
Operable Unit 7 Feasability Study
Portsmouth Naval Shipyard, Kittery, Maine



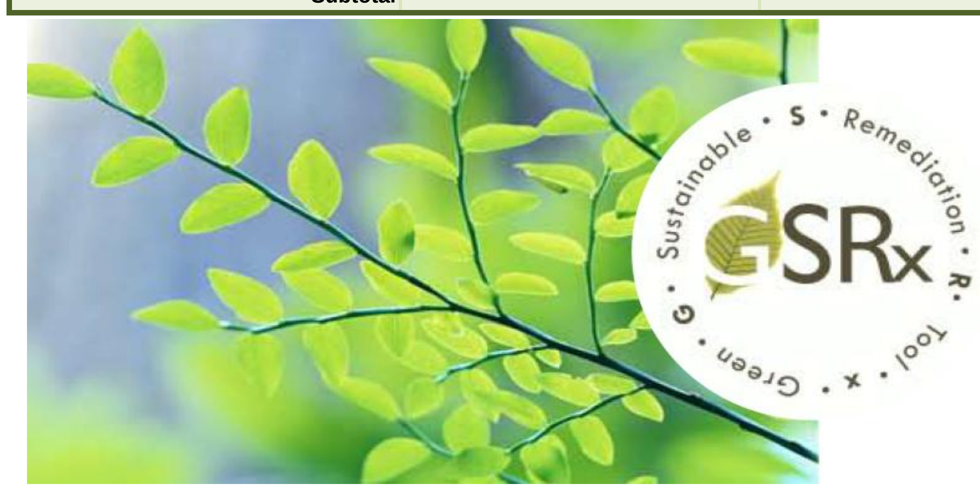






GSRx Results Alternative 3
OU7, Portsmouth Naval Shipyard
Kittery, Maine

	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
						$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**						**Tonnes**						**MWhr**	**gal x 1000**
RAC	Asphalt (crushed)	Asphalt	(2500 sf, 0 .083 ft thick, 140 lbs/ft3)	29050	lbs	0.30	0.24	1.65E-04	4.87E-05	0.00E+00	3.03E-05	2.11E-01	1.32	0.00
RAC	Sand (dry)	Sand	(2500 sf, 0 .17 ft thick, 100 lbs/ft3)	42500	lbs	0.10	0.10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60	0.00
RAC	Concrete (gravel)	Gravel	(2500 sf, 0 .5 ft thick, 150 lbs/ft3)	187500	lbs	1.45	1.45	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	34.46	0.00
RAC	Temporary Equipment Decon Pad Liner	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.471211	lbs	1.56	0.83	1.97E-03	6.04E-03	0.00E+00	3.49E-03	5.08E-04	9.17	0.25
RAC	Temporary Equipment Decon Pad Frame	Wood	Assume wood, 4x4 in, (30ftx40ft pad) 140 ft of timber, density for pine 530 kg/m3	514.683708	lbs	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Backfill, common fill	Soil	186 cy, assume soil, 1.5 ton/cy; 50 miles in	558000	lbs	5.82	5.82	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	153.81	0.00
RAC	Geotextile Fabric	HDPE	Assume similar to US TM Track Mat (Extra Heavy),7.33 lbs/sy, given 285 sy, HDPE	2089.05	lbs	4.66	2.46	5.87E-03	1.80E-02	0.00E+00	1.04E-02	1.52E-03	27.34	0.75
RAO	Backfill Gravel	Gravel	82 CY, assume 1522 kg/cm3, year 15 and year 30	420,728.00	lbs	3.24	3.24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	77.31	0.00
RAO	Rip Rap	Gravel	Assume gravel, 14 CY, 1522 kg/cm3, year 15 and year 30	71,831.61	lbs	0.55	0.55	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	13.20	0.00
	Subtotal					**17.69**	**14.70**	**8.01E-03**	**2.41E-02**	**0.00E+00**	**1.39E-02**	**2.13E-01**	**319.21**	**1.01**
Stage	**Construction Equipment**						**Tonnes**						**MWhr**	**gal x 1000**
RAC	Compactor Attachment	Compactor 120 hp	assumed 120 hp, assumed 8 hr/day, 4 days, assume diesel	25.6	hrs	1.02	1.02	0.00E+00	0.00E+00	8.30E-03	0.00E+00	6.94E-04	4.73	
RAC	Excavator, 2.5 cy	Excavator, Hydraulic, 2 CY (diesel)	1 excavators, 10 days, assumed 8 hrs/day, 80% utilization	64	hrs	6.20	6.20	0.00	0.00	3.90E-02	1.15E-02	3.71E-03	28.16	
RAC	Pavement Saw, 18 hp	Chainsaw, gasoline, 3<hp<=6, 2 stroke	3 days, 8 hours per day, 80% utilization	19.2	hrs	0.04	0.04	0.00E+00	0.00E+00	6.96E-05	0.00E+00	5.13E-04	0.18	
RAC	Asphalt paver	Paver, 100 HP (diesel)	1 asphalt paver, 130 hp, 1 tandum roller, 10 tons, 1 day of equipment use, 80% utilization	6.4	hrs	0.23	0.23	4.48E-06	9.60E-06	1.62E-03	3.90E-04	2.18E-04	0.78	
RAC	Tandem Asphalt Pavement Roller	Roller, 100 HP (diesel)	BW 900-50 light tandem roller, 1 ton, 1 day of use 80% utilizatio	6.4	hrs	0.23	0.23	3.84E-06	9.60E-06	1.61E-03	3.84E-04	2.18E-04	0.76	
RAO	Excavator, 2.5 CY	Excavator, Hydraulic, 2 CY (diesel)	5 days, 8 hours per day, 80% utlization, year 15 and year 30	64.00	hrs	6.20	6.20	0.00	0.00	3.90E-02	1.15E-02	3.71E-03	28.16	
RAO	Front End Loader, 4 CY (185 hp)	Loader, 200 HP, 4 CY (diesel)	5 days, 8 hours per day, 80% utlization, year 15 and year 30	64.00	hrs	2.07	2.07	0.00	0.00	1.89E-02	3.92E-03	2.27E-03	7.56	
	Subtotal					**16.00**	**15.99**	**8.32E-06**	**1.92E-05**	**1.08E-01**	**2.77E-02**	**1.13E-02**	**70.33**	**0**
				Total		**34**	**31**	**0.01**	**0.02**	**0.11**	**0.04**	**0.22**	**390**	**1**



Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
		Tonnes						**MMBTU**	**gal**
RI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAC	21.61	18.62	2.49	0.51	0.05	0.03	0.22	898.40	1,006.25
RAO	12.07	12.07	0.00	0.00	0.06	0.02	0.01	430.71	0.00
LTM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

APPENDIX F

RESPONSES TO COMMENTS ON THE FEASIBILITY STUDY REPORT FOR OU7

TETRA TECH

PITT-10-12-056

October 25, 2012

Project Number 112G02100

Mr. Matthew Audet
USEPA, Region 1
5 Post Office Square
Suite 100
Mail Code OSRR07-3
Boston, Massachusetts 02109-3912

Mr. Iver McLeod
Maine Department of Environmental Protection
State House Station 17
Augusta, Maine 04333-0017

Reference: Contract No. N62470-08-D-1001 (CLEAN)
Contract Task Order No. WE13

Subject: Responses to Comments on the Draft Feasibility Study Report for Operable Unit 7
Portsmouth Naval Shipyard (PNS), Kittery, Maine

Dear Mr. Audet/Mr. McLeod:

On behalf of the U.S. Navy, Tetra Tech, Inc. is pleased to provide to U.S. Environmental Protection Agency Region I (USEPA) and Maine Department of Environmental Protection (MEDEP) 2 and 3 copies, respectively, of the subject responses to comments dated August 14, 2012 (USEPA) and July 31, 2012 (MEDEP). An electronic copy is being provided via email.

In accordance with the project schedule, comments are due by **November 23, 2012**.

If you have any comments or questions, or if additional information is required, please contact Ms. Elizabeth Middleton at 757.341.1985.

For the Community Restoration Advisory Board (RAB) members; if you have any comments or questions on these issues, they can be provided to the Navy at a RAB meeting, by calling the Public Affairs office at 207.438.1140 or by writing to:

Portsmouth Naval Shipyard
Public Affairs Office
Attn: Danna Eddy
Portsmouth, NH 03804-5000

Sincerely,

Deborah J. Cohen, P.E.
Project Manager

DJC/clm
Enclosure

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NAVFAC MIDLANT. (Code OPTE3/E. Middleton)
NAVFAC MIDLANT PWD ME (Code PRN4, M. Thyng)
James Forelli, Tetra Tech
NIRIS RDM

RESPONSES TO USEPA COMMENTS DATED AUGUST 14, 2012
DRAFT OPERABLE UNIT 7 FEASIBLITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

General Comments

The dioxin PRGs for workers and residents are based on outdated OSWER soil guidance for dioxin. The new PRGs are 664 ng/kg for workers and 50 ng/kg for residents. The PRGs on Table 2-4 of the draft FS are 0.02 mg/kg (20,000 ng/kg) for workers and 0.001 mg/kg (1,000 ng/kg) for residents. Thus the new PRGs are 20 times lower for residents and 30 times lower for workers. The new PRGs are found at question no. 3 at http://epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html. Please revise as appropriate, also the dioxin reference on page 5 of Appendix 5-1, Table 5-1.

Navy has discussed the fact that the area around former building 237 was evaluated separately because there were statistically different contaminant concentrations in those samples as compared to the rest of OU7. It is not apparent how Navy performed the 95% UCL calculations that determined the exposure point calculations. Please confirm that the exposure point concentrations presented for OU7 do not include samples located in the area around former Building 237.

Response: As discussed during the October 16, 2012 Remedial Project Manager (RPM) call, the Navy will use USEPA's updated (February 2012) reference dose (RfD) for 2,3,7,8-TCDD to calculate a site-specific non-carcinogenic risk-based preliminary remediation goal (PRG) for dioxins/furans [based on 2,3,7,8-TCDD toxicity equivalent quotient (TEQ) concentrations]. The Navy requests that USEPA provide written assurance that the OU7 cleanup goal for dioxins/furans and the selected remedy for OU7 will not need to be revised if a cancer toxicity value (slope factor) for 2,3,7,8-TCDD is established in the future.

OU7 site-specific exposure factors will be used to calculate the non-carcinogenic risk-based PRG for OU7. Preliminary calculations indicate that the OU7 dioxin/furan PRGs (based on 2,3,7,8-TCDD TEQ and a hazard index of 1) for residential and industrial worker will be approximately 50 ng/kg and 600 ng/kg, respectively. Section 2.0 and Appendix A will be revised as appropriate to reflect removal of the OSWER soil guidance and inclusion of a risk-based PRG for dioxins/furans. Please also see the Navy's response to MEDEP Comment No. 5 regarding other changes to the PRGs.

Exposure point concentrations (EPCs) presented in the FS are the entire site soil EPCs from the Remedial Investigation (RI) Report (Tetra Tech, July 2011). The sample locations from the area around former Building 237 were included in these calculations. The FS will be updated to include EPCs for the entire site, for the area around former Building 237, and for the site without the samples from the area around former Building 237.

Specific Comments

1. **Comment: Page ES-2, Executive Summary:** The partial paragraph at the top of the page states that only small pockets of waste have been detected at OU7 so it is not considered a landfill. Review of Figure 4-1 in the Remedial Investigation Report indicates that almost all borings in the fill since 1925 as well as the area of the timber basin contain waste and those areas comprise the majority of OU7. The alternatives presented would leave contamination in place at concentrations that far exceed unrestricted use standards, and as noted in the text,

groundwater transport is a potential migration pathway. Groundwater monitoring would therefore be required for OU7 to assure that contaminants are not migrating from the site. The alternatives presented need to be revised to include groundwater monitoring at the perimeter of the waste management area boundary.

Response: The conceptual site model (CSM) discussed on Page ES-2, and further discussed in Section 1.7, is based on the conclusions provided in the RI Report for OU7 (Tetra Tech, July, 2011) (see Section 1.6 for a summary of the RI Report). Results of the RI do not support that there is municipal or industrial waste at OU7 or that the contaminants in the fill material are of a nature that are releasing or would result in a future release of contaminants that would adversely impact groundwater. The CSM acknowledges that groundwater transport is a potential migration pathway; however, the risk and modeling results show that this pathway is not a current or future pathway of concern. As discussed further in this response, the site was filled over 50 years ago, mostly with rock and soil, and the fill material and contaminants found in the fill would not result in any new or sudden contaminant releases that would adversely impact groundwater. The three rounds of groundwater monitoring conducted between 1998 and 2008 and contaminant fate and transport modeling for OU7 support that there are no current or future unacceptable risks for exposure to groundwater or for migration of groundwater to the offshore. Given the age and conditions at the site and the groundwater monitoring and modeling results, there are no current or future risks for groundwater and groundwater monitoring is not required for any remedial alternative for OU7. Therefore, the alternatives in the FS will not be revised to include groundwater monitoring. The text discussing the summary of the RI Report (Section 1.6) and CSM (Section 1.7) will be revised to provide more support for the conclusion that groundwater migration is not a pathway of concern.

OU7 is an area that was filled with various materials from approximately 1900 to 1945 to provide land to support PNS operations. The area was a mudflat and the entire OU7 area is tidally influenced with the majority of fill material in the tidally saturated or saturated zone.

Boring logs and cross-sections provided in the RI Report do not indicate municipal or industrial waste in the fill material at OU7. Figure 4-1 of the RI Report indicates whether any debris or waste was found in the boring. Waste at OU7, as referenced in the RI Report, was considered where there was a pocket of concentrated debris (debris material with little soil). Debris includes slag, ash, metal, cinders, coal clinkers, wood, plastic, glass, concrete, porcelain, and brick, depending on the location at the site. As discussed in the RI and summarized in Section 1.6.1.5 of the FS Report, the fill material consists of surface fill consisting principally of sand with gravel, angular rock fragments, and silt. Debris was found throughout the site intermingled with the surface fill. And there were a few localized pockets of waste (concentrated debris) in the central portion of the site. By volume, the majority of the fill material consists of angular rock fragments composed of dark gray, fine grained quartzite. Site cross-sections (Figure 3-2 of the RI), show areas referred to as surface fill which contained no debris; areas referred to as surface fill with debris which contained primarily surface fill by volume, with some occasional debris; and areas referred to as waste which contained debris with no soil material. As shown in the cross-section figures the amount of waste (concentrated debris) and surface fill with debris is negligible by volume compared to the volume of surface fill.

The site has been used for industrial uses since filling began; however, concentrations do not support that there is high-level contamination across the site. Concentrations of some chemicals in the fill material (mostly subsurface soil) across most of the site exceed residential risk levels and therefore, most of the site is included within the proposed residential LUCs boundary. Within the former timber basin, there is an area with elevated concentrations of total polychlorinated biphenyls PCBs (based on total Aroclor concentrations) and dioxins/furans (based on 2,3,7,8-TCDD TEQ). This is the area near sample locations TP-SB27, TP-SB112 and TP-SB14/TPSB108. Concentrations of PCBs and dioxins/furans exceeded the industrial PRGs in this elevated contaminant area. Outside of this area at OU7 concentrations of PCBs and dioxins/furans were at acceptable levels. PCB concentrations (based on total Aroclors) and dioxins/furans concentrations (based on 2,3,7,8-TCDD TEQ) outside of the elevated contaminant concentration area ranged from approximately 0.05 to 2.6 mg/kg (industrial worker PRG is 7.4 mg/kg) and approximately 0.2 to 34 ng/kg (industrial worker PRG will be approximately 600 ng/kg), respectively. These concentrations are also less than the residential PRGs. PCBs and dioxins/furans do not tend to migrate in groundwater and have not been detected in groundwater or offshore media at unacceptable concentrations.

Three rounds of groundwater data were collected from 1998 to 2008 to evaluate groundwater concentrations at OU7. Site overburden groundwater data indicate that inorganics and organic chemicals are not leaching from soil to groundwater at concentrations that would adversely impact human health or the environment. This is supported by the risk assessment and contaminant fate and transport modeling for OU7 presented in the RI Report. For the risk assessment, there were no human health chemicals of concern (COCs) for OU7 groundwater or surface water. Concentrations of chemicals in groundwater also were less than screening levels for potential to adversely impact surface water when groundwater migrates from the site to near-shore surface water. Regarding groundwater transport of contamination, as summarized in Section 1.6.3 of the FS Report and further discussed in the RI Report, contaminant fate and transport modeling was performed to conservatively estimate potential impacts from migration of contamination from soil to groundwater and then to intertidal sediment and near-shore surface water. The modeling assumed the pavement at OU7 was removed; that the amount of infiltrating precipitation coming in contact with soil would be greatly increased compared to current conditions; and that the overall groundwater flow conditions and contributions from storm water sewer discharge would not change significantly in the future (i.e., fill material at the site will still be in contact with water). The modeling results using unsteady state and steady state parameters indicate that surface water is not and would not in the future be adversely impacted by onshore sources of contamination. Using unsteady state parameters, the modeling conservatively indicates that sediment may potentially be impacted through the onshore migration of metals contamination through groundwater. Observed concentrations of metals in sediment are orders of magnitude less than the modeled results and do not indicate groundwater migration is adversely impacting sediment. In summary, the RI concluded that groundwater, surface water, sediment, and soil data for OU7, and modeling conclusions show that the migration of contaminants in groundwater from OU7 to the offshore does not pose a current risk and would not pose a future risk.

2. **Comment:** **Page 1-7, Section 1.6:** The mean high water elevation in NAVD 1988 is said to be 3.58 feet; however, this value appears inconsistent with the mean high water elevation presented in the remedial design for OU2.

   Response: The text will be corrected to indicate that the 2002 PNS vertical datum relates 0 in NAVD 1988 to 96.78 feet (Civil Consultants, 2002). Regarding the mean high and low water elevations, these were updated in the Remedial Action Design for OU2. As part of the remedial design, data for the NOAA Seavey Island Tidal Station (Station ID 8419870) were evaluated to determine whether the mean high and low water elevations had been updated based on the recent NOAA tidal epoch (1983 to 2001). The last NOAA tidal epoch was from 1960 to 1978, which had a mean low water elevation of 92.22 feet and a mean high water elevation of 100.36

feet 2002 PNS vertical datum. As provided in the remedial design, using the 1983 to 2001 tidal epoch data for the Seavey Island Tidal Station, the updated elevations are 92.47 and 100.58 feet PNS 2002 vertical datum for mean low and mean high water elevations, respectively. Mean high and low water elevations presented in the FS will be updated to reflect the 1983 to 2001 tidal epoch.

3. **Comment: Page 1-15, Section 1.6.4:** The first sentence on this page refers to residents and occupational workers as future receptors due to the existence of pavement over the site. In the absence of current LUCs, please revise the text accordingly to identify current receptors to accessible soil.

   Response: The text in Section 1.6.4 is a summary of the RI Report (Tetra Tech, July 2011) and no changes to the site have occurred that would change the exposure for current receptors. Although occupational workers currently use the site, the majority of the site is covered by pavement and areas that are not covered by pavement are covered by grass or riprap; therefore, occupational worker exposure to soil is not a current exposure route. Residents are not current receptors at the site. H23 is a temporary housing unit and is surrounded by paved parking areas to the north, east, and west and a grass covered area with trees to the south; therefore, there would not be exposure to soil for these receptors and any future potential exposure would be more similar to an occupational worker or recreational user than a resident. Therefore, for exposure to soil in the RI, the occupational worker and recreational user were only evaluated for future potential exposure. Presenting residents and occupational workers as current receptors exposed to soil would provide an unrealistic impression that these receptors are being exposed to soil at the site. Table 1-2 and the text following will be clarified to indicate that although current site users, there is no current exposure to soil for occupational workers and recreational users.

4. **Comment: Page 1-17, Section 1.6.5:** The first sentence states that the boundary for OU7 is defined by the historical fill lines. There are several unpaved areas adjacent to the perimeter of the boundary and some samples with PRG exceedances are located in those areas. The final boundary for the proposed LUCs cannot be established without confirmation that the extent of the LUC boundary is adequate and protective.

   Response: Section 1.6.5 of the FS Report is a summary of the conclusions in the RI Report, which concluded that the site boundary for OU7 is defined by the historical fill lines. Within this boundary the Navy accepts that contamination is more likely from a CERCLA release or historically filling of the site than from general industrial use such as railroads or roadways. The Navy will use the limits of potentially unacceptable residential risk as shown on Figure 2-1 for the residential LUCs boundary and will not include adjacent areas within this LUCs boundary. Outside of this boundary is considered under Shipyard control and Shipyard land use and procedures for management of excavated soil are in place to provide any protection needed for any area outside of OU7.

5. **Comment: Tables 2.1, 2.2, 2.3:** EPA has not completed its review of ARARs at this time.

   Response: No response required.

6. **Comment: Page 2-12, Table 2-4:** a) Please correct the typographical error for the PRG listed for iron; the value should be 27,000 not 2,700.

   b) Table note 2 states that the construction and occupational workers are evaluated together and have the same PRGs. A construction worker will have significantly greater exposure to soil than an occupational worker so it is unclear why Navy would group these two receptors together.

<u>Response:</u> a) The PRG listed for iron will be corrected to 27,000 mg/kg to match the value listed in Appendix A.1

b) Construction and occupational workers were evaluated together as an industrial worker for PRG selection to simplify the determination of remedial areas. Risk-based construction and occupational worker PRGs were developed separately as shown in Appendix A-1 of the FS. The lesser of the calculated PRG between the construction worker and occupational worker was presented as the Industrial Worker PRG on Table 2-4 of the FS.

7. **<u>Comment:</u> Figure 2-1:** This figure shows the limits of potentially unacceptable risk for residential receptors and indicates that the filled area in the vicinity of former Building 237 is not included. The last sentence on page 1-15 states that risk was only evaluated for construction workers for the former Building 237 area. If that statement is correct please clarify how Navy determined that there is no potential risk in this area for residential receptors.

   <u>Response:</u> The last sentence on page 1-15 will be deleted. In the Risk Characterization Section of the RI Report, risk was only evaluated for construction workers for the former Building 237 area. Risks for all other receptors for the former Building 237 area were evaluated in the Uncertainty Section of the RI Report.

8. **<u>Comment:</u> Table 3-1:** Signs, identified as active controls in Table 3-2, will be required to identify the existence of the LUCs. Please reconcile.

   <u>Response:</u> The screening comment for the active controls in Table 3-2 will be corrected to "Eliminate" because active controls are not necessary to prevent current site users from exposure to subsurface contamination at the site. Consistent with LUCs for other sites, passive controls such as mapping the LUC boundary on Shipyard land use maps and other land use restrictions are required.

9. **<u>Comment:</u> Table 3-2:** Please revise the screening comment for *Asphalt Cover*. Groundwater monitoring will determine if contaminant migration is a concern. Make the same correction for *Cap*.

   <u>Response:</u> The screening comment for Asphalt Cover will be corrected to "Eliminate" because a cover is not required to prevent current or future exposure to surface soil based on industrial site use and migration of soil contaminants to groundwater is not a current or future concern for the site. The screening criteria for Cap will be revised to read similarly. As provided in the RI Report (see Section 7.2.1), groundwater, surface water, sediment, and soil data from OU7 and modeling conclusions show that migration of contaminants in groundwater from OU7 to the offshore does not pose a current risk and would not pose a future risk; therefore, groundwater monitoring will not be included as a component of any of the remedial alternatives. Please also see the Navy's response to USEPA Comment No. 1 regarding groundwater.

10. **<u>Comment:</u> Page 4-6, Section 4.2.1.2:** The paragraph at the top of the page states that there are no location-specific ARARs for Alternative 1; that is not correct (see Table B-1). Please delete "location- or" from the sentence.

    <u>Response:</u> The text in Section 4.2.1.2 is correct, there are no location-specific ARARs for Alternative 1 (No Action). The location-specific ARARs listed on Table B-1 pertain to remedial activities such as excavation that could occur in the locations specified in the ARARs (e.g., coastal area, floodplain). There are no remedial activities considered for the No Action Alternative. Therefore Table B-1 will be updated to remove the location-specific ARARS and no change is needed for Section 4.2.1.2 regarding location-specific ARARs.

11. **Comment:** **Page 4-10, Section 4.2.3.2:** The text states that with the removal of the two hot spots the risk for industrial exposure to subsurface soil would be reduced to acceptable levels. This is only true considering average subsurface soil concentrations but construction worker exposure does not actually occur at average concentrations but at specific locations. Because there are many locations where elevated levels of contamination will be left in place in excess of risk-based levels for construction workers, a land use restriction must be implemented over these areas to adequately protect construction workers. Based on the areal extent of sampling construction worker LUCs are probably needed over most of OU7.

    Response: Exposure does not occur at average concentrations but it also does not occur at one specific sampling location only. Exposure occurs over areas referred to as exposure units. Risk assessment guidance was written to conservatively account for receptor exposures by utilizing 95 percent upper confidence limits (UCLs) on the mean concentration of chemicals of potential concern (COPC) over an exposure unit. The 95 percent UCL is greater than the average concentration. The exposure unit for the construction worker was defined in Section 6.0 of the RI Report as the entire site; therefore, risks were calculated based on 95 percent UCLs for COPCs based on data sets for the entire site (except for lead which is based on an average concentration). Based on the risk assessment, the COCs that pose a potential risk for construction workers are dioxins/furans and PCBs. Industrial PRGs were developed for these COCs. Review of the individual sample results for dioxins/furans (based on 2,3,7,8-TCDD TEQ) and total PCBs shows that elevated concentrations of these COCs only occur in the two areas within the former timber basin, and not at many locations. The areal extent of sampling supports that LUCs are not necessary over most of OU7 to protect construction workers; however, LUCs for residential use would be required for most of OU7. Additional clarification of the elevated concentrations of contamination in the former timber basin will be added to the discussion in the FS (e.g., Section 2).

    The specific individual sample results that exceed the risk-based PRG levels for the construction worker are at the three locations included in the limited excavation area provided in Alternative 3. These exceedances were dioxins/furans (based on 2,3,7,8-TCDD TEQ) at TP-SB27 (1.7 µg/kg),, and total PCB concentrations at TP-SB112 (19.1 mg/kg), TP-SB14 (21.5 and 44.4 mg/kg), and TP-SB108 (41.1 mg/kg). There were no other exceedances of the risk-based PRG levels for dioxins/furans and PCBs; therefore, after excavation of the elevated contaminant concentrations in the two areas within the former timber basin, no further LUCs for industrial use are necessary to protect construction workers from exposure to subsurface soil. For Alternative 2, LUCs for industrial use are only needed in the two areas identified in the former timber basin. Figure A-3 shows the two areas with elevated dioxins/furans and PCB concentrations and the industrial receptor PRG exceedances for total PCBs. This figure will be revised to show the exceedance of the dioxins/furans PRG (at TP-SB27) based on the update that will be made to the dioxins/furans PRG..

12. **Comment:** **Figure 4-1:** The industrial LUC boundary presented in this figure would not be protective of construction workers because these workers would be exposed to location-specific contaminant concentrations not average site-wide concentrations. Navy probably needs a construction worker LUC over most if not all of OU7 to restrict access to soil. The same comment also applies to Figure 4-2 for Alternative 3.

Response: Please see the Navy's response to USEPA Comment No. 11. No change to Figures 4-1 and Figures 4-2 are required based on this comment.

13. **Comment:** **Figure 4-2:** EPA notes that the residential building (H23) is located within the boundary defining potentially unacceptable residential risk where a residential LUC will be imposed. Please clarify how this will be addressed going forward and whether additional sampling in a pre-design investigation will be needed to remove Building H23 from the residential LUC area.

    Response: H23 is temporary housing (transient barracks) used to house transient Navy personnel and is not a military or long-term residence. Therefore, the transient Navy personnel housed in H23 are not evaluated using a residential exposure scenario. No additional sampling would be required in a pre-design investigation and H23 will remain in the residential LUC area. Please also see the Navy's response to USEPA Comment No. 3 regarding H23.

14. **Comment:** **Page 5-1, Table 5-1:** Please correct the ARARs evaluation for Alternative 1; it would not comply with all ARARs.

    Response: Table 5-1 will be updated for Alternative 1 to indicate that there are no chemical-, location-, or action-specific ARARs and that chemical-specific TBCs would not be met. This change will also be made to Section 4 text related to Alternative 1.

15. **Comment:** **Appendix A.1 Page 5:** The dioxin reference cited is outdated and needs to be removed for the FS together with the PRGs cited in this reference.

    Response: The cited OSWER reference will be removed and PRGs for dioxins/furans will be updated. Please see the Navy's response to USEPA General Comment for the update to the dioxins/furans PRGs.

16. **Comment:** **Appendix A.1 Figure A-1:** Boring TP-SB120 at the western extent of OU7 had a lead concentration of 3,980 mg/kg in surface soil in an unpaved area. No other samples have apparently been collected farther to the west to define the limits of this contamination in the unpaved or paved areas. It is not appropriate to limit the extent of LUCs here and elsewhere as depicted without further confirmation that the limits of unacceptable contaminant concentrations have been defined.

    Response: As stated in the nature and extent section of the RI, "TP-SB120 has detected concentrations of total PCBs, lead, and PAHs in excess of risk-based screening levels TP-SB120 is located near Goodrich Avenue and the railroad tracks, and the elevated concentrations of total PCBs, lead, and total carcinogenic PAHs could be related to use of Goodrich Avenue and the railroad tracks." Therefore it is assumed that elevated lead concentrations at TP-SB120 (611 mg/kg in the original sample and 3,980 mg/kg in the duplicate sample) are not related to any site sources including the historical filling of the site or timber basin activities so the OU7 boundary will not be impacted by these results. Please also see the Navy's response to USEPA Comment No. 4 regarding site boundary.

17. **No comment was provided.**

18. **Comment:** **Appendix C:** Alternative 2 nor Alternative 3 includes costs for maintaining and repairing the pavement surface; however, the description of the required LUCs for both alternatives includes retaining the existing site features to prevent exposure to soil and the surface migration of soil contaminants. Therefore, maintenance and repair of the pavement will be required regularly over the life of the remedy and costs need to be included for this work.

Response: There are no current or future unacceptable risks due to surface soil exposure for current receptors and there are only potential unacceptable risks for exposure to surface soil for the hypothetical future residents. LUCs in Alternatives 2 and 3 restrict residential use of the site so that there is no need to maintain or repair pavement to prevent exposure to soil at OU7. Therefore, costs for long-term maintenance and repair of pavement do not need to be included in the costs for Alternatives 2 and 3. Maintenance of existing conditions in the alternatives is to maintain the shoreline erosion controls to prevent potential future erosion of contaminated soil to the offshore. The text in Section 4 will be revised to clarify that long-term management in these two alternatives is for the shoreline controls.

19. **Comment:** **Appendix D Page 2 of 3:** Please correct the volumes at the bottom of the page for consistency. 6 cubic yards should apparently be 3 cubic yards and 19 cubic yards should apparently be 14 cubic yards.

    Response: An assumed larger area for pavement replacement than pavement removal was used to calculate the volume of asphalt because of possible damage to surrounding areas during excavation.

RESPONSES TO MEDEP COMMENTS DATED JULY 31, 2012
DRAFT OPERABLE UNIT 7 FEASIBLITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

Specific Comments

1. **Comment:** **Fig. 1-3.** This and other figures have a balloon indicating the filled area near the former Building 237. For clarification refer to section 1.6.2 and/or App. A.2 in the balloon wherever it occurs.

   Response: Text boxes in figures identifying the filled area near former Building 237 will be updated to include a reference to section 1.6.2 and Appendix A.2.

2. **Comment:** **ARARs tables.** Add the following items:

   - Federal Chemical-specific:
     - TBC - Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. (USEPA, January 2003)
   - State Chemical-specific[1]:
     - TBC - Maine Remedial Action Guidelines (RAGS) For Soil Contaminated with Hazardous Substances (MEDEP, January 2010);
     - TBC - Guidance for Human Health Risk Assessments for Hazardous Substance Sites in Maine (MEDEP and MECDC, July 2009)

   Response: Both of the documents "*Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil (USEPA, January 2003*)" and "*Guidance for Human Health Risk Assessment for Hazardous Substance Sites in Maine (MEDEP and MECDC, July 2009)*" were considered and cited for the OU7 human health risk assessment in the RI Report; however, these documents will not be added to ARARs tables in the FS because these references were not used in the development of PRGs. Consistent with the OU2 FS Report, the document "*Maine Remedial Action Guidelines (RAGS) For Soil Contaminated with Hazardous Substances (MEDEP, January 2010)"* will be added to the ARAR tables in Section 2 of the FS as TBC and then screened out in the alterative-specific ARAR tables in Appendix B because site-specific PRGs are being used instead of RAGs values.

3. **Comment:** **2.4, p. 2-11.** The Navy states they based the PRG for manganese on a "more realistic construction worker exposure frequency" (60 days/yr) than what was used in the Human Health Risk Assessment (150 days/yr). It is inappropriate to change values that were used in the risk assessment without discussion with the regulators. MEDEP cannot accept the reduced manganese exposure frequency for construction workers and the resulting elimination of Mn as a CoC without further discussion.

[1] Note that any hazardous substance site in Maine requiring cleanup of contaminated soil must consider Maine RAGS and/or Maine Guidance for Human Health Risk Assessments. Cleanups that do not consider these guidance documents are not acceptable to MEDEP.

Also, please explain why the Navy did not change exposure frequencies for other CoCs to "more realistic levels" since exposure frequencies should be the same for all parameters.

Response: Use of a construction worker exposure frequency of 60 days per year is based on likely construction worker exposure at OU7 and is consistent with construction worker PRG development in the OU1 and OU2 FS reports. All construction worker risk-based PRGs were developed using a 60 days per year exposure frequency as shown in the risk-based construction worker PRG calculations included in Appendix A.1. Text will be added to Section 2 to clarify that all construction worker PRGs were developed based on an exposure frequency of 60 days per year.

4. **Comment: Table 2-4, p. 2-11.** Clarify that cPAHs refers to benzo(a)pyrene equivalents.

   Response: Table 2-4 will be revised to clarify that carcinogenic PAHs are referring to benzo(a)pyrene toxicity quotient equivalents (BAP TEQ).

5. **Comment: Table 2-4, p. 2-11.** Given our recent discussions regarding improper use of Non-detect values in calculating representative background values, especially for PAHs, the PRG for cPAHs is suspect. MEDEP must discuss this further with the Navy before we can accept this PRG.

   Response: The Navy and MEDEP have not resolved the appropriate use of non-detected values for calculating representative background values; however, the representative background value will not be used for the carcinogenic PAHs PRGs for OU7. The Navy calculated a residential risk-based PRG for carcinogenic PAHs of 0.5 mg/kg based on an incremental lifetime cancer risk (ILCR) of 3.3×10^{-5}. The USEPA acceptable risk range for carcinogens is 1×10^{-6} to 1×10^{-4}. There are three carcinogenic COCs at OU7 so the ILCR limit of 1×10^{-4} was divided by 3 which equals 3.3×10^{-5}, so that the cumulative cancer risk would not exceed 1×10^{-4} if PRGs are met for all three carcinogenic COCs. Appendix A will be updated to present this calculation. Table 2-4 will be updated based on the calculation.

6. **Comment:** Although acceptable for the scenario of subsurface soils brought to the surface, the Navy needs to be cautious in applying the PNSY background values to subsurface soils. All background data represented surface soils, and in the case of PAHs and other potentially anthropogenic compounds the surface soil concentrations can be higher than the subsurface concentrations.

   Response: No revision is required based on this comment. PAHs are COCs for subsurface soil for residential land use based on the potential for subsurface soil to be brought to the surface. For excavation and management of soil, the Shipyard maintains a policy that includes soil testing and disposal requirements. This policy has been included as part of the LUC RDs (e.g., OU1, OU2, and OU3).

7. **Comment: Table 2-4, footnote 1.** "PRGs are EPCs…" This statement is somewhat confusing as PRGs are not necessarily EPCs. It would be better to state that, "PRGs are the desired EPCs…" or something similar.

   Response: The text will be revised to read "PRGs are the goals for representative exposure concentrations for an exposure unit and are not intended as pick-up levels."

8. **Comment: Alternative 2, Short-Term Effectiveness, p. 4-8.** Please clarify in the text why this evaluation includes excavators since Alternative 2 consists solely of LUCs and long-term management.

<u>Response:</u> For costing in the FS, long-term management of the shoreline controls was assumed would require maintenance of the shoreline controls every 15 years and would consist of removal and replacement of a portion of the existing controls. Therefore, as part of the long-term management of the shoreline controls, it was assumed that excavators would be needed. The text will be clarified to include the assumptions regarding shoreline maintenance for Alternatives 2 and 3. In addition, the assumptions regarding excavation for Alternative 3 will be included.

9. **<u>Comment:</u>** **Alternative 3, Excavation and Off-site Disposal, p. 4-9.** The Navy should be prepared to excavate below the high tide mark if confirmation samples indicate that the limits of contamination have not been reached.

   <u>Response:</u> The excavation is to address human health risk exposure to unsaturated soil. There are no unacceptable risks for migration of groundwater; therefore, excavation in the saturated zone is not needed to be protective of human health and the environment. The depth below mean high tide line for excavation is typically only slightly below high tide. This depth would be provided in the Remedial Action documents (e.g., Remedial Action Design or Remedial Action Work Plan).

RESPONSES TO USEPA FOLLOW-ON COMMENTS DATED DECEMBER 11, 2012
DRAFT OPERABLE UNIT 7 FEASIBLITY STUDY
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

1. **Comment:** *General Comments:* Concur. Navy requested written assurance that the OU7 cleanup goal for dioxins/furans and the selected remedy for OU7 will not require revision if a cancer toxicity value (slope factor) for 2, 3, 7; 8-TCDD is established in the future. EPA believes that the appropriate response to this request is the written guidance at question no. 2 at http://epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html which states the following:

   Dioxin-contaminated sites cleanup up based on the new non-cancer RfD are not expected to need additional cleanup when a new EPA cancer toxicity value for dioxin is published in EPA's Integrated Risk Information System (IRIS). This is because we anticipate that dioxin cleanup levels based on the new non-cancer RfD will be within the cancer risk range currently used by EPA's Superfund and RCRA cleanup programs.

   Response: The Navy concurs that the cited written guidance is sufficient assurance that the OU7 cleanup level for dioxins/furans will not require revision if a cancer toxicity value (slope factor) for 2,3,7,8-TCDD is established in the future.

2. **Comment:** *Comment 3, Page 1-15, Section 1.6.4:* According to the response, the temporary housing unit H23 has a grass covered area with trees to the south. Consistent with standard risk assessment practice for residential use at other sites, grass is not a barrier to contact with surface soil for residents because residential adults could dig in soil for landscaping and gardening, and children could dig in soil for play. Therefore, surface soils in the grass covered area should be evaluated for future normal residential risk unless a LUC is established that prohibits residential use other than temporary housing for adults only.

   Response: Building H23 is a hotel named the Navy Gateway Inns and Suites (NGIS), which the Navy considers transient housing as opposed to temporary housing where families would stay for several years. Exposure to potential receptors at Building H23 under the current site use as a hotel is not the same as a residential (temporary or long-term) exposure scenario. It is noted that potential future residential risks for exposure to surface and subsurface soils were evaluated in the RI. In addition, Building H23 is within the residential land use controls (LUCs) boundary evaluated in the FS. Current use of Building H23 would not be prohibited with implementation of LUCs.

   To clarify that Building H23 is a hotel, text in Section 1.6.4 immediately beneath Table 1-2 will be revised to read as follows:

   "Building H23 at OU7 is a hotel named the Navy Gateway Inns and Suites (NGIS), which the Navy considers transient housing as opposed to temporary housing where families would stay for several years. Hotel receptors would have far less exposure to potentially contaminated soil, if any, than residential receptors; therefore, potential hotel receptors were not considered residential receptors and residential receptors were not evaluated as a current receptor."

   Additionally, references to Building H23 as temporary housing throughout the FS will be amended to refer to that building as a hotel.

3. **Comment:** *Comment 7, Figure 1-2:* The response states that risks in the Building 237 area for all other receptors except construction workers were discussed in the Uncertainty Section of the RI Report. Please provide a copy of the specific language and documentation in the Uncertainty

Section that addresses residential risk for soils in this area for EPA evaluation or add a LUC prohibiting residential use in this area.

Response: The 2nd paragraph on p.6-36 of the OU7 RI addresses residential risk for soils in the former location of Building 237. The referenced paragraph is listed below.

"Risks due to subsurface soil in the former location of Building 237 were also evaluated. Risk results tables (RAGS-Part D 7 and 9 tables) for soil from the former location of Building 237 are presented in Appendix D.7.1. RME all-media cumulative ILCRs are less than or within the USEPA target range ($1x10^{-6}$ to $1x10^{-4}$) and do not exceed the State of Maine risk guideline when subsurface soil from the former location of Building 237 is considered for occupational workers, recreational users (adult, adolescent, lifetime), and adult and child residents. The RME cumulative ILCR for lifetime residents exposed to subsurface soil slightly exceeds the Maine risk guideline but is within the USEPA target risk range (the lifetime resident ILCR of $2x10^{-5}$). RME non-cancer estimates are less than USEPA threshold (1) for the receptors evaluated."

4. **Comment:** *Comment 13, Figure 4-2:* to prevent children or long-term residential use of H23 temporary housing, please add language to the LUC that prohibits any residential use other than temporary housing by adults only.

   Response: Building H23 is a hotel (please see the Navy's response to USEPA Comment No. 2 regarding Building H23). According to Figure 4-2, residential LUCs would be placed on the portion of Building H23 within OU7. Current use of Building H23 would not be prohibited with implementation of LUCs.

5. **Comment:** *Comment 16, Appendix A.1, Page 5:* The response suggests that Navy is not responsible for contaminants related to the use of Goodrich Avenue and the railroad tracks. This is incorrect. Navy is responsible for all contaminants on the site.

   Response: The original comment is discussing the lead concentrations at TP-SB120 and the western boundary of OU7. The response was not intended to suggest that the Navy is not responsible for contamination within OU7 but rather that the OU7 boundary is not impacted by the lead concentration results in surface soil at TP-SB120.

   The site boundary is based upon historic fill lines (as discussed in the OU7 RI report). Given the site history and the nature of the filling operations, the contamination is not expected to migrate. Therefore all sampling was conducted within the site boundary.

   Based on the sampling, three areas with distinct concentration distributions were found: (1) an area with elevated contaminant concentrations compared to the rest of the site (within the former timber basin), (2) an area with concentrations significantly less than the rest of the site (area in the vicinity of former Building 237), and (3) the general site (rest of the fill material at the site).

   The general site has a large range of concentrations, indicative of the heterogeneous nature of the fill. While on the upper end of the distribution, the lead concentration in the soil sample from TP-SB120 was within the statistical range of concentrations for the area, and thus does not indicate a separate source of contamination. Because of the heterogeneous nature of the fill, and the process by which the site boundary was identified for the general site area, the Navy will maintain land use controls on the portions of the site that contain average concentrations above acceptable levels, even though there are sample points that do not pose unacceptable risk.

RESPONSES TO MEDEP COMMENTS DATED APRIL 29, 2013
DRAFT FINAL FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 7
PORTSMOUTH NAVAL SHIPYARD, KITTERY, MAINE

1. **Comment:** As discussed in recent emails and phone calls, the Navy should calculate the non-carcinogenic risk from PCBs at the site, as an addendum to the OU7 risk assessment. Since there is no reference dose for Aroclor 1260, the most common at OU7, the Navy calculated the total PCBs PRG based on carcinogenic numbers. However, non-carcinogenic risk for PCBs is greater than carcinogenic risk in some risk scenarios. Except for the Commercial scenario the non-cancer risk is a significant risk driver for PCBs.

   As previously discussed, because there is no reference dose for Aroclor 1260 the Navy should use the reference dose for Aroclor 1254 as a surrogate. The use of a surrogate will lead to uncertainty and this should be discussed in the addendum. In addition to the addendum, the FS should indicate what the PRG would be based on non-carcinogenic PCBs.

   Because of the hot-spot nature of PCB-contaminated soil at the site, excavation to or below the carcinogenic PRG will also result in excavation of soil to the non-carcinogenic PCB. For this reason, <u>and at Site 32 only</u>, the MEDEP is willing to base remediation of PCB-contaminated soil on the carcinogenic PRG.

   Should this issue arise at any other Installation Restoration sites at the Portsmouth Naval Shipyard we will have to discuss how to proceed at that time. However, based on our knowledge of the other IR sites on the yard we don't expect this to be a future issue.

   Response: Appendix A.1 Development of Preliminary Remediation Goals was revised to include a section on titled "UNCERTAINTY EVALUATION FOR PRG FOR TOTAL PCBS" and the non-carcinogenic PCB PRGs using the Aroclor-1254 reference dose as a surrogate were added to the PRG calculations in Appendix A.1.

2. **Comment:** RTC 3. "Use of a construction worker exposure frequency of 60 days per year is based on likely construction worker exposure at OU7 and is consistent with construction worker PRG development in the OU1 and OU2 FS reports."

   Construction worker exposure duration at one OU or site should not necessarily be assumed to be the same duration at another OU or site. Exposure duration largely depends on the types of construction work performed at any one site and this of course can vary between sites. In this situation, MEDEP agrees that 60 days is appropriate.

   Response: Comment noted.

3. **Comment:** RTC 9. If a typical excavation depth could result in unacceptable exposure for a construction worker then the contaminated soil should be removed regardless of whether or not the soil is saturated. This does not mean we expect the Navy to excavate to a depth of 9 feet but rather to a depth typical for excavations at the Shipyard. We note that the Navy took into account removing soil to a depth of 9 feet bgs in the quantity calculation (App. D) and cost estimate for Alternative 3 (App. C.2).

   Response: Comment noted.